ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXXI. No. 6.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 109

The Properties and Uses of Aluminum..... 110
Teredo-Proof Sheathing for Piles (*illustrated*)..... 111
Sharp Curves in Railway Track (*illustrated*)..... 112
The East Providence Stand-Pipe Failure (*illustrated*)..... 112
A Cool Hand Wheel for Steam Valves (*illustrated*). 113
Notes by Rail..... 113
The Tiber Creek Sewer Flush Gates, Washington, D. C. (*illustrated*)..... 114
Frankel's Deflection Meter for Measuring Bridge Vibrations (*illustrated*)..... 115
Professor Durand's New Rule for Integration..... 115
Inspecting Steam Engines and Boilers in Massachusetts..... 115
The Raddatz Submarine Boat..... 116
Passenger Traffic on a Cableway..... 116
The Metropolitan Sewerage System of Massachusetts (*with inset*)..... 121
Lining a Water-Works Tunnel with Concrete..... 123
Water Purificat on in America..... 123
Resistance of Soils to Erosion by Water (*illustrated*) 124

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS..... 116

EDITORIAL NOTES..... 118

The Proposed New York-Philadelphia Electric Railway—Ship Canal Projects.

EDITORIALS..... 118

The Last Rapid Transit Proposition for New York. Speed Premiums in Naval Contracts.

LETTERS TO THE EDITOR..... 120

Recording the Vibrations of Bridges—Early Steel Bridges in America—Of Interest to Bridge Engineers—Concerning Magnetic Variation—"A Conundrum in Transit Work"—Improvised Protractors—Standard Size for Pamphlets, etc.

CONSTRUCTION NEWS..... 125

Railways, Street and Electric Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous Contracts and Supplies.

INDUSTRIAL NOTES..... 128

The Hurontario Ship Canal & Power Co. is asking the Ontario Legislature for papers of incorporation. This company proposes to build a waterway between Georgian Bay, opening into Lake Huron and Lake Ontario, capable of passing the largest lake steamers. The capital stock is placed at $65,000,000, and the company pledges itself to spend $1,000,000 within the next 18 months and $5,000,000 in five years and to complete the canal within ten years. The fall between Georgian Bay and Lake Ontario is 200 ft., which must be overcome by locks. This route would entirely cut out Lake Erie and the difficult navigation by way of the St. Clair River, Lake St. Clair and the Detroit River into Lake Erie. The trouble will be to find the $65,000,000.

Locomotives with four coupled driving wheels under the boiler and a four-wheel trailing truck under the bunker are largely used for suburban service on English railways. These locomotives somewhat resemble the Forney type generally used in this country on elevated railways, but are considerably larger and have side and rear tanks instead of a rear tank only. The front drivers have underhung plate springs, and the main drivers underhung coiled springs. The principal dimensions of some engines of this type recently built by the Southeastern Ry. at its shops from the designs of Mr. James Stirling, Locomotive Superintendent, are as follows:

Driving wheels	5 ft. 6 ins.
Truck wheels	3 " 9½ "
Wheel base, driving	7 " 5 "
" truck	5 " 4 "
" total	22 " 0 "
Weight on drivers (31,024 and 35,840 lbs.)	66,864 lbs.
" total	108,976 "
Cylinders (inclined 1 in 9)	18 × 26 ins.
Boiler, diam	4 ft. 4 "
Firebox, length	4 " 9⅛ "
" width	3 " 4 "
Grate area	15.5 sq. ft.
Tubes, number, 185; diam.	1¾ ins.
" length	10 ft. 7⅛ ins.
Heating surface, tubes	833.30 sq. ft.
" " total	922 55 "
Smokestack, diam.	1 ft. 4 ins.
" height from rail	13 " 4 "
Capacity of tanks	1,260 galls.
" " bunker	3,900 lbs.
Brake fittings	Automatic vacuum

Two powerful compound express locomotives have been built by the Swiss Locomotive Works, at Winterthur, for hauling express trains on the Saint Gothard Ry. without changing engines. One of the locomotives has three cylinders, the high pressure in the middle. On the level and on easy grades the steam from the high-pressure cylinder will exhaust into the two outside, while on heavy grades all three cylinders will take steam directly from the boiler. The other engine has four cylinders, coupled two and two, so as to constitute two compound engines when the traction is easy, or four high-pressure cylinders on heavy grades.

The Lake St. Clair-Lake Erie Ship Canal is the latest project in that line. It is a Chicago enterprise and the purpose of the projectors is said to be the avoidance of the Limekiln Channel and some other dangerous places, and the shortening of the route to Buffalo, N. Y., by 100 miles. Mr. D. F. Henry, of Detroit, is Chief Engineer.

Gas explosions are still of frequent occurrence in Chicago's electrical subways. It will be remembered that when New York first began building electrical subways several years ago, explosion in the manholes were frequent and terrifying. The cause was ascertained to be the leakage of illuminating gas into the subways, and the trouble was permanently cured by the establishment of a system of ventilation by blowers, under which the barometric pressure in the subway ducts is maintained a little above the pressure of the percolating gas.

The Hudson Tunnel Railway Co. held a meeting in London on Jan. 24 to hear the report of the committee appointed to consider the prospects for the completion of a railway tunnel under the Hudson River at New York. According to this committee, nothing has been actually done as yet to provide the money required. The chief trouble to be now dealt with is a lien upon the £250,000 of unissued bonds made by the construction company. This the committee thought could be arranged. To carry out the original prospectus of the company would require the raising of further millions of pounds to acquire land in New York and provide the proposed railway terminals and connections. This the committee did not propose to do at this time, but it thought a sufficient revenue could be secured from the rental of the tunnel for gas and water pipes, pneumatic tubes, telegraph and telephone wires, and probably electric car transit for passengers, to warrant the raising of the sum required to finish the one tunnel from bank to bank of the river. This completion would cost from $750,000 to $1,000,000, and was strongly urged by Mr. Pearson, one of the late contracting firm. Mr. Pearson also said that he showed his faith in the future of the tunnel by not only taking all his pay in second bonds but in investing $55,000 of his own cash in maintaining the tunnel.

A project for an elevated electric road is before the council of Philadelphia. The Market St., Richmond & Frankford Elevated Electric Ry. Co. is the name of the new corporation and indicates the route selected. The proposed line covers eight miles of double track, and the company proposes to pay one-half of 1% of gross receipts into the city treasury, this payment to commence two years after the road has gone into operation. The company must file a bond of $200,000 to secure the city against damages to property, and another bond of $50,000 for faithful performance of work. The fare is to be 5 cts. in the day and 10 cts. at night. The proposition is referred to a joint committee of select council for consideration. The members of the company mentioned are Messrs. G. F. Jordan, G. F. Keene, Theodore Cramp, Wm. H. McManus and John Dougherty. Mr. Cramp is the president.

The most serious railway accident of the week was the derailment of a construction train at Curran, Ill., on the St. Louis, Chicago & St. Paul R. R., Jan. 28, in which one man was killed and several were injured.

A crowded car on the San Francisco & San Mateo Electric Ry. ran away on a heavy grade Jan. 27, jumping the track and colliding with one of the posts supporting the overhead wires. The car was upset and 21 persons were injured, some of whom are not expected to live. According to the reports the brakes refused to act, and when the motorman reversed the current the fuse burned out and the car got beyond control. It is also reported that passengers are allowed to ride on the front platform, thus hampering the motorman. ——Another runaway of an electric car occurred at Albany, N. Y., Feb. 1, owing to the failure of the brake. The car was going down the State St. hill and collided with another car, one person being seriously injured.

The New York Rapid Transit Commission has approved of the Wilson plan for obtaining the end desired, and has recommended it to the Mayor as the only plan feasible. This plan, as already outlined in this journal, provides for the construction of a two-story, four-track tunnel, on the route laid down by the Commission, at an estimated cost of $45,000,000, two-thirds of which is to be paid by the city and one-third by private capital. After three years of public discussion of the problem the Commission has evidently abandoned all hope of construction by private capital alone. The Commission, in its letter of recommendation to Mayor Gilroy, recognizes the financial standing of R. T. Wilson & Co., coupled with its offer to deposit $1,000,000 in approved securities to be forfeited to the city in case of failure to sign the contract for construction. It is recommended that this proposition be submitted to the Constitutional Convention and to popular vote for approval. The city loan would be based upon the completion first of not less than two miles of the proposed road by private capital. The Mayor does not favor any loan to private corporations, and says he will not support it.

A project to build a great ship basin in the South Cove is being considered by the Jersey City Street and Water Commissioners. The plan is to convert this shallow water into a storage basin somewhat similar to the Erie Basin, in Brooklyn, at an estimated cost of $1,500,000. This South Cove covers an area equal to about six city blocks, and by building piers and storage warehouses and dredging out to a depth of at least 20 ft. at low tide, this now practically waste property of the city can be made to yield a handsome revenue.

The municipal building project for New York is in as deep a muddle as ever. Judging from the expression of views by Mayor Gilroy and his architectural advisers, the probable outcome of the competition, by which 134 plans were obtained, will be the rejection of all plans and the employment of a competent architect to study carefully the requirements of the various city departments and to prepare a plan based upon the data thus obtained; obtain careful estimates of cost and finally submit to the board a design which it is known will accommodate all the departments at a minimum cost for a solidly built, fireproof structure of plain design. The board can add to this estimate whatever sum is deemed expedient for purely ornamental work, and finally offer very liberal premiums for the best five designs that do not exceed the specified cost. In the opinions of competent architects the exterior should be designed to fit the interior uses of the building; whereas, in the plans submitted, the reverse process prevailed.

Comparative tests of the performance of a Baldwin ten-wheel four-cylinder compound engine and a Baldwin ten-wheel simple engine have been made on the Long Island R. R., the two engines being similar in all respects except the compounding. Each engine made ten round trips daily (113.78 miles per day) for three days, with the same train of 20 loaded cars, making a trainload of 819 net tons. The same coal was used on both engines. The leading dimensions of the engines were as follows:

Driving wheels, diameter	5 ft. 9-16 in.
Weight on drivers	78,700 lbs.
Weight, total engine	106,150 lbs.
Weight, engine and tender	173,150 lbs.
Cylinders (4, compound)	12 × 24 ins. and 20 × 24 ins.
Cylinders (2, simple)	18 × 24 ins.
Boiler (wagon top), diameter	4 ft. 6 ins.
Working pressure, compound	180 lbs.
" " simple	145 lbs.
Grate area	22½ sq. ft.
Heating surface	1,342¾ sq. ft.

The principal difference in working was that the safety valves of the compound were set at 180 lbs., and those of the simple engine at 145 lbs. The general average results of the test were as follows:

	Compound. lbs.	Simple. lbs.
Evap., lbs. of water per lb. of	7.32	5.55
Coal burned per train-mile	54.40	85.80
Coal burned per car-mile	2.72	4.34
Coal burned per ton-mile per hour	0.01254	0.01847
Average economy per ton-mile per hour	32.1%	.....
Average economy in water per ton-mile per hour	10.7%	.....
Average economy per car-mile, fuel	37.2%	.....
Average econ. per car-mile, water	37.2%	.....

According to the bill being prepared by the House Committee on Rivers and Harbors, the amount of $15,000,000 will be appropriated for this purpose, or only about one-half of the estimates sent in by the engineer officers of the army.

Aluminum price lists for plate, sheet and wire aluminum, over 98% pure, are issued by the Pittsburg Reduction Works, of Pittsburg, Pa. The plate and sheet list include sizes from 3 to 28 ins. wide, and the price ranges from 90 cts. to $1.50 per pound, according to width and thickness. Aluminum wire ranges from $1.25 per pound, for Nos. 9 to 14 B. & S. gage, to $2.58 for No. 27 gage. No. 1 aluminum, over 98% pure, ranges in price from 75 cts. per pound, for small lots, to 65 cts. in ton lots. No. 2 aluminum, over 94% pure, costs from 73 cts. to 60 cts. per pound up to ton lots.

A storm water sewer, with vertical walls and arched top and bottom, has just been completed on one of the principal streets of Berlin, Germany. It is 265 ft. in length and its cross-section is 3 ft. 4 ins. wide and 4 ft. high. The floor is of concrete blocks covered with a layer of hard burned brick.

THE PROPERTIES AND USES OF ALUMINUM.

The rapid growth in the production of aluminum, in the United States and in Europe, and the rapid extension of its use as its properties are better understood, make interesting reading of the following abstract of the report upon this metal made by Mr. A. E. Hunt for the "Report on the Mineral Resources of the United States" for 1892:

In the United States the production commenced with 83 lbs. in 1883; rose to 3,000 lbs. in 1886; 19,000 lbs. in 1889; 47,468 lbs. in 1889; 61,281 lbs. in 1890; and jumped to 150,000 lbs. in 1891, and to 259,885 lbs. in 1892. France commenced the manufacture of this metal in 1855; in 1890 that country was making only about 6,000 lbs., with a total of 126,000 lbs. made up to and including 1890. For the two years 1891-92 the output was about 100,000 lbs. The total English product up to Jan. 1, 1891, is estimated at 42,000 lbs.; and the output of the two years 1891-92 would add 180,000 lbs. The German and Swiss production figures at 43,120 lbs. up to the year 1890, when the works at the Falls of the Rhine were started. Private, but reasonably accurate, data place the production from these works at 120,000 lbs. of pure aluminum in 1890; 360,000 lbs. in 1891; and 720,000 lbs. in 1892, or a total of 1,200,000 lbs. for the three years.

These figures may be tabulated as follows, showing the world's total production of aluminum to Jan. 1, 1893, and the enormous increase in the product since 1890:

	Total production to Jan. 1, 1891.	Production, Jan. 1. 1891, to Jan. 1, 1893.	Total to Jan. 1, 1893.
Great Britain	42,000 lbs.	180,000 lbs.	222,000 lbs.
France	126,000 "	100,000 "	226,000 "
Germany and Switzerland	163,120 "	1,080,000 "	1,243,120 "
United States	149.245 "	409,885 "	559,130 "
	480,365 lbs.	1,769,885 lbs.	2,250,250 lbs.

Mr. Hunt estimates that out of this 1,125 short tons of aluminum produced in the world up to and including 1892, about 1,000 tons represents pure aluminum, and the odd 125 tons is represented by aluminum-bronze, or ferro-aluminum alloys. As shown above, the world's production of aluminum in the two years 1891-92 about quadrupled the total production in the world up to the beginning of 1891.

Aluminum is now sold in the market in the form of ingots, plates, sheets, bars, shapes, wire and castings. Practically all of the aluminum made in the United States is manufactured under the patents of C. M. Hall for the electrolytic process; the sodium process has never been worked on any large scale in this country. Since January, 1893, the Pittsburg Reduction Co. is the only manufacturer of aluminum, commercially, in the United States.

The report devotes considerable space to the metallurgy of aluminum, describing the sodium and electric processes in full. The principal sources of alumina are now cryolite from Greenland, and bauxite from enormous deposits lately discovered in Georgia, Alabama and Arkansas; the latter ore being delivered at Pittsburg at a cost of $7 per ton, in 1893, and containing 52 and 53% of alumina for the Arkansas ore, and 59% for the best bauxite from Georgia and Alabama. This mineral has already been mined in lots of thousands of tons. Aluminite, a mineral containing from 20 to 30% of alumina in a condition to be cheaply purified by solution, filtration and roasting, is found in large beds in several of the Western states, and it may become a cheap source of alumina in the future. At present excessive freight charges prevent its commercial use. The importation of bauxite into the United States has dropped from 28,945,674 lbs. in 1889 to 12,804,253 lbs. in 1892, owing to the mining of this product in Georgia and Alabama.

Much erroneous data are still being published regarding the properties of aluminum. Mr. Hunt, who is probably the best informed man on this subject in the United States, gives these properties as follows: 1, relative lightness; 2, its ability to resist corrosion as compared with many other metals; aluminum not being acted upon at all by sulphur fumes, and is very much more slowly acted upon by a moist atmosphere than most metals; 3, its extreme malleability; 4, its easy casting qualities; 5, its high specific heat and heat conductivity; 6, its relatively high electrical conductivity; 7, its high tensile strength and elasticity, when weight for weight of the metal is compared with other metals, especially when alloyed with a small percentage of silver, copper or other metals and properly worked by being rolled, hammered, drop-forged or otherwise drawn out thereafter; 8, the valuable alloys it makes with other metals.

Taking the above properties in more detail, it is found that the specific gravity of pure aluminum in a cast state is 2.58; in rolled bars of large section it is 2.6; in very thin sheets subjected to high compression under chilled rolls it is as much as 2.7. Taking the weight of a given bulk of cast aluminum as 1, wrought iron is 2.90 times heavier; structural steel, 2.95 times; copper, 3.60; ordinary high brass, 3.45; nickel, 3.50; silver, 4; lead, 4.80; gold, 7.70; and platinum, 8.60 times heavier. Most wood suitable for use in structures has about one-third the weight of aluminum, which weighs 0.092 lb. to the cubic inch.

Owing to its stability in the atmosphere and non-corrosive qualities, pure aluminum is used for a packing or gasket in steam connections, as it is practically not acted upon by boiling water or steam. Carbonic oxide or hydrogen sulphide does not act upon it at any temperature under 600° F. It is not acted upon by most organic secretions, or by most of the solutions used as germicides, hence it is receiving favorable and considerable use for surgical instruments, suture wires, and wherever it is subjected to carbolic acid or other antiseptic solutions.

Hydrochloric acid is the best solvent for aluminum, and strong solutions of caustic alkalies readily dissolve it. Ammonia has a slight solvent action, and concentrated sulphuric acid dissolves aluminum upon heating, with evolution of sulphurous acid gas. Dilute sulphuric acid acts but slowly on the metal; though the presence of any chlorides in the solution allow rapid decomposition. Nitric acid, either concentrated or dilute, has very little action upon the metal, and sulphur has no action unless the metal is at a red heat. Seawater has very little effect on aluminum, and strips of the metal placed on the sides of a wooden ship corroded less than 1-1,000 in. after six months' exposure to seawater, corroding less than copper sheets similarly placed. But, unfortunately, barnacles seem to thrive on it as they do on steel plates. For structural purposes under water, where metal is required, aluminum has been successfully used and stands the effects of time and corrosion much better than wrought iron or steel, or even cast iron, under similar conditions. Aluminum is being used for shims in masonry foundations, owing to is non-corroding qualities.

Though little used as yet for this purpose, the prospects are that aluminum will be largely used for roofing, when the price in sheets will compare with the price of copper. For this use it is recommended with the caution that aluminum stands very high in the series as an electro-positive metal, and contact with other metals should be avoided, as it would establish a galvanic couple.

Aluminum will take and retain a polish fully equal to that on silver; it can be scratch-brushed to a beautiful finish, and can be dipped and pickled and spun.

In malleability pure aluminum is only exceeded by gold and silver. In ductility it stands seventh in the series, being exceeded by gold, silver, platinum, iron, very soft steel and copper. Sheets of aluminum have been rolled down to a thickness of 0.0005 in. and beaten into leaf nearly as thin as gold leaf. As leaf it is now largely used for decorative purposes; and, as it takes oil colors very well, all the artistic work in the decoration of the Transportation Building, at the Columbian Exposition, was painted upon a base of thin beaten aluminum foil. The metal is most malleable at a temperature of between 400° and 600° F., and at this temperature it can be drawn down between rolls with nearly as much draft upon it as with heated steel. It has also been drawn down into the very finest wire. By the Mannesmann process aluminum tubes have been made in Germany on a large scale and as successfully as with other metals.

Sound castings can be made of aluminum in either dry or "green" sand molds, or in metal "chills." It must not be heated much beyond its melting point and must be poured with care, owing to the ready absorption of occluded gases and air. The shrinkage in cooling is 17-64 in. per ft., or a little more than ordinary brass. It should be melted in plumbago crucibles, and the metal becomes molten at a temperature of 1,120° F., according to Professor Roberts-Austin, or at 1,300° F. according to Richards' work on "Aluminum."

Aluminum hollowware castings represent one of the largest present demands for the metal. Aluminum teakettles are now on the market, and coffeepots and teapots will soon follow. Hollowware castings in the form of teakettles have been successfully made with 1-16 in. thickness in the walls; and a decided advantage is that these castings are more malleable than other metals, such castings having been hammered in and bent almost double before breaking. By the Smith pressure casting process, the finest details of the engraving, chasing and repousse work are brought out in aluminum with a finish equal to an electrotype.

The coefficient of linear expansion, as tested on ⅜-in. round aluminum rods, is 0.00002295 per degree Centigrade between the freezing and boiling point of water. That of iron under similar conditions is 0.0000122; tin, 0.0000217; and copper, 0.00001718. The mean specific heat of aluminum is higher than that of any other metal, excepting only magnesium and the alkali metals. From zero to the melting point it is 0.2185; water being taken as 1, and the latent heat of fusion at 28.5 heat units. The coefficient of thermal conductivity of unannealed aluminum is 37.96; of annealed aluminum, 38.37. As a conductor of heat aluminum ranks fourth, as follows:

Silver	100.0	Tin	14.5
Copper	73.6	Iron	11.9
Gold	53.2	Steel	11.6
Aluminum, annealed	38.37	Platinum	8.8
" unannealed	37.96	Bismuth	1.8

Due to its high specific heat, high heat conductivity, its lightness and non-tarnishable qualities, aluminum is particularly well adapted for cooking utensils, and a considerable demand for it for this use has already been established and will undoubtedly grow rapidly. It is very much better for this purpose than copper, which must be tinned, and in covered dishes retains heat particularly well.

The electrical conductivity of aluminum is only surpassed by pure copper, silver and gold. With silver taken at 100 the electrical conductivity of aluminum is 54.20; that of gold on the same scale is 78; zinc is 29.90; iron is only 16, and platinum, 10.60. Pure aluminum has no polarity and the metal in the market is absolutely non-magnetic. These properties have already caused it to be considerably used in electrical appliances and seem to adapt it well for use in astronomical and other physical instruments.

In the important quality of strength, aluminum, under tension, and section for section, is about as strong as cast iron. But when the fact is taken into consideration that section for section pig iron, wrought iron, or steel, would weigh three times as much as aluminum, the relative tensile strength of the new metal assumes further importance. The tensile strength of aluminum is increased by cold rolling or cold forging, and there are alloys which add considerably to the tensile strength without increasing the specific gravity to over 3 or 3.25. The Pittsburg Reduction Works are now furnishing this metal in commercial quantity in angles, plates, channels and other sections for structural work in aluminum.

The strength of commercial aluminum is given in the following table as the result of many tests:

Form.	Elastic limit per sq. in. in tension, lbs.	Ultimate strength per sq. in. in tension, lbs.	Percentage of reduct'n of area in tension,
Castings	6,500	15,000	15
Sheet	12,000	24,000	35
Wire	16,000-30,000	30,000-65,000	60
Bars	14,000	28 000	40

The elastic limit per sq. in. under compression in cylinders, with length twice the diameter, is 3,500. The ultimate strength per sq. in. under compression in cylinders of some form is 12,000. The modulus of elasticity of cast aluminum is about 11,000,000. Aluminum in castings can read-

ily be strained to the unit stress of 1,500 lbs. per sq. in. in compression, and to 5,000 lbs. per sq. in. in tension. It is rather an open metal in its texture and for cylinders to stand pressure an increase in thickness must be given to allow for this porosity. Taking aluminum in relation to its weight, it is as strong as steel of 80,000 lbs. per sq. in.

The strength of aluminum as compared with other metals is given as follows by Richards:

Metals.	Weight of 1 cu. ft. in., lbs.	Tensile strength per sq. in., lbs.	Length of a bar able to support its own weight, in ft.
Cast iron	444	16,500	5,351
Ordinary bronze	525	36,000	9,893
Wrought iron	480	50,000	15,000
Hard structural steel	490	78,000	23,040
Aluminum	168	26,800	23,040

Under torsional stress in Thurston's torsional machine, the metal has much lower modulus of rigidity than iron or steel; its maximum shearing stress in castings being about 12,000, and in forgings, about 16,000; or about that of pure copper. The angle of torsion is about equal to that of the softest steel. The report gives a full table of torsional tests of aluminum.

Alloys of aluminum and copper form two series, both valuable. The first is aluminum-bronze, containing from 5 to 11½% of aluminum; and the second is copper-hardened aluminum, containing from 2 to 15% of copper. Aluminum-bronze is a very dense, fine-grained and strong alloy, having good ductility as compared with tensile strength. The 10% bronze, in forged bars, will give 100,000 lbs. tensile strength per sq. in., with 60,000 lbs. elastic limit per sq. in. and 10% elongation in 8 ins. The 5 to 7½% bronze has a specific gravity of 8 to 8.30, as compared with 7.50 for the 10 to 11½% bronze, a tensile strength of 70,000 to 80,000 lbs., an elastic limit of 40,000 lbs. per sq. in., and an elongation of 30% in 8 ins.

Mr. A. W. Cadman, of Pittsburg, Pa., has patented the use of ½ of 1% of aluminum with the ordinary tin-antimony-copper Babbitt metal for bearings, and this compound is now used in the hardest classes of bearings with very satisfactory results. The peculiarity is that this alloy can be readily hammered or rolled into bars and shapes.

Aluminum is being used regularly by many of the largest steel companies to prevent the retention of the occluded gases in the steel and thereby produce a solid ingot. The proportions of the dose range from ½ lb. to several pounds of aluminum per ton of steel. Aluminum is also much used in giving extra fluidity to steel used in castings, making them sharper and sounder. Added to cast iron aluminum causes the iron to be softer, free from shrinkage and lessens the tendency to "chill."

With the exception of lead and mercury aluminum unites with all metals; though it unites with antimony with great difficulty. A small percentage of silver whitens and hardens the metal and gives it added strength, and this alloy is especially applicable to the manufacture of fine instruments and apparatus. The following alloys have been found recently to be useful in the arts: Nickel-aluminum, composed of 20 parts nickel to 8 of aluminum; rosine, made of 40 parts nickel, 10 parts silver, 30 parts aluminum and 20 parts tin, for jewelers' work; mettaline, made of 35 parts cobalt, 25 parts aluminum, 10 parts iron and 30 parts copper. The aluminum-bourbounz metal, shown at the Paris Exposition of 1889, has a specific gravity of 2.9 to 2.96, and can be cast in very solid shapes, as it has very little shrinkage. From analysis the following composition is deduced: Aluminum, 85.74%; tin, 12.94%; silicon, 1.32%; iron, none. Professor Roberts-Austin has discovered a beautiful alloy of a rich purple or ruby tint, made of 22 parts aluminum to 78 parts of gold. An addition of 5 to 15% of aluminum to type metal, of 25% antimony and 75% lead, gives a sharper and more durable casting. Added to zinc it gives a thinner and more tenacious covering in the galvanizing process.

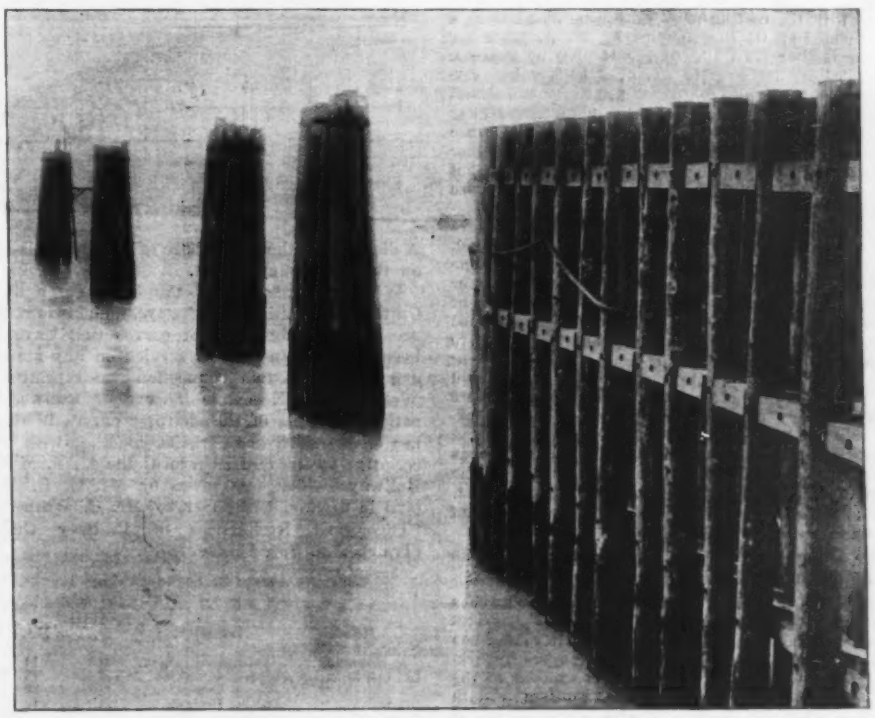
Aluminum can now be successfully plated with gold, silver, nickel and even bronze, and it is claimed that the plated article can be bent double and then straightened without cracking the plating. The metal can be readily electrically welded, but soldering is still not satisfactory. The high heat conductivity of the aluminum withdraws the heat of the molten solder so rapidly that it "freezes" before it can flow sufficiently. A German solder, said to give good results, is made of 80% tin to 20% zinc, using a flux composed of 80 parts stearic acid, 10 parts chloride of zinc and 10 parts of chloride of tin. Pure tin, fusing at 250° C., has also been used as a solder. The use of chloride of silver as a flux has been patented, and used with ordinary soft solder has given some success. A pure nicked soldering bit should be used, as it does not discolor aluminum as copper bits do.

Aluminum slate pencils have been lately put upon the market, in the form of wire with a sharpened point. It is as satisfactory as an ordinary slate pencil and is much more durable. Aluminum is also now used with claimed advantages for sounding-boards in stringed instruments. Used in the form of horse-shoes it has showed less wear than iron shoes, and the aluminum shoe is lighter and preserves the feet of the horse better. Racing shells and yachts are made of aluminum, and steam launches made of the new metal are also afloat.

TEREDO-PROOF SHEATHING FOR PILES.

Protecting piles against the teredo has been successfully accomplished for several years on the Pacific coast by the use of a protecting covering manufactured by the Standard Paint Co., of New York city, the well known manufacturers of "P. & B." paints. The pile to be protected is first barked and trimmed of knots, etc., from a point which will be about 1 ft. below the mud surface when driven to a point at the level of mean tide. This surface is next painted with a coat of P. & B. compound and then covered with the protecting covering, which is simply burlap saturated with the compound. This is protected from injury during the driving of the pile by covering it with wooden battens nailed on. The total cost of protecting a pile in this manner is said to be about 36 cts. per lin. ft., covered. This makes the cost for this method of protection especially small where piles are used in shallow water. Among the railway companies on the Pacific Coast which have extensively used this method of protection are the Northern Pacific, Great Northern, San Francisco & Northern Pacific and Seattle, Lake Shore & Eastern.

The accompanying illustration is from a photograph of a freight car transfer ferry slip of the San Francisco & Northern Pacific R. R., at Tiburon, Cal., built in 1889. The battens covering the protecting sheathing can be seen on the piles, extending about 3 ft. above the water. The illustration will be of interest to many engineers as showing a system of fastening spring piling which dispenses with the use of planking, and also for the use of "dolphin clusters," to guide the boats as they enter the slip.



PORTION OF FERRY SLIP OF SAN FRANCISCO & NORTHERN PACIFIC R. R., TIBURON, CAL., SHOWING PILES PROTECTED BY P. & B. SHEATHING.

As many of our readers are probably aware, attempts to protect piles from the teredo by sheathing have been often tried. Some ten years ago tests were made by the California Board of Harbor Commissioners on piles protected by various kinds of sheathing. Mr. Howard C. Holmes, Chief Engineer of the Board, has furnished a copy of the records of these tests which we reprint as follows:

Pursuant to an order of the Board of State Harbor Commissioners and subsequent advertisement, sundry devices were presented to the Board for protecting the submerged piles from the teredo and limnoria. During the month of June, 1882, piles prepared by the persons named herein were driven in the Mission St. pier.

A. W. von Schmidt, of San Francisco, prepared two piles; Frank Shay, of San Francisco, prepared 23 piles; McKeon & Co., 393 Second St., Oakland, prepared 10 piles; W. H. Raye, 809 Webster St., Oakland, prepared 20 piles; Peace & Beardsley, 839 9th St., Oakland, prepared 44 piles. The bark from each of these piles had been removed from a length of 40 ft., which was the length of the part prepared.

A. W. von Schmidt's method is essentially a loose jacket of earthen sewer pipe, with the interior space filled with hydraulic cement. The sections of said pipe had interior diameters of 14 ins., and were 2 ft. in length. After the pile had been driven and sawed off these sections were slipped over the top of the pile, socket end up. The first section was so held that it could be lowered as the succeeding sections were placed and their joints cemented, care being taken as the sections were lowered to keep the pile central in the pipe. When a proper bearing in the mud was found the work was completed by filling the circular space with grout composed of gravel, sand and Portland cement, which soon sets.

Frank Shay prepared the piles by coating them with two coats of common asphalt applied so hot as to run easily. After the first coat had hardened the pile was wrapped with iron wire cloth, 16 meshes to the inch. The second coating was then applied, and before cooling sulphate of lime was dusted over the surface. The asphalt does not adhere well to the pile, but in hauling and driving the coating remained intact, so far as could be discovered.

McKeon & Co. used a coating of "marine cement," so called. It was applied with a brush in four coats, time being given between the applications for the cement to harden, which it did not do very well. In handling to get the piles in place, which was carefully done, the coating on each of the piles was more or less chafed. This office has not been informed what

the ingredients of the cement are, nor the manner of its preparation, but was informed that it contained an extremely poisonous substance, upon which the protection from the worms would be largely due.

The coating which W. H. Raye placed upon the piles was largely composed of Portland cement; the other ingredients are unknown to this office. The composition was applied with a brush, in three coats, and time given between each for hardening, which it did indifferently well. Although carefully handled in getting the piles to place, they were all badly chafed, and in some instances the coating was entirely removed from the pile. After the piles were driven Mr. Raye recoated the broken parts between high and low water.

Peace & Beardsley covered the piles with "Peace's compound," so called. This office has no knowledge of its composition, except that paraffin, limestone, kaolin and sawdust form a part of it. It was applied hot, the temperature about 350°, one workman pouring it upon the pile from a ladle, and another brushing it down with a common broom. After cooling, which occurred immediately, the piles were wrapped with burlap, and a second coat applied in the manner first described. This compound is extremely adhesive; it becomes solid and is considerably elastic. In handling and driving the piles the coating was in no way disturbed as far as could be discovered. (By direction of the chief engineer five of these piles were prepared without burlap, which was objected to by Messrs. Peace & Beardsley.)

March 1, 1883.—The prepared piles under Mission St. pier were inspected this day and their conditions found to be as follows: Two piles jacketed with drain pipe by Von Schmidt, remain as when first put down. Of the 23 piles by Frank Shay, the covering of 6 is sound, 14 are becoming rusty, the salt water having reached the wire cloth, and on 3 the coverings are broken. Of the 10 piles by McKeon & Co., 9 were found with the coating practically gone and 1 is in a fair condition. Of the 20 piles by W. A. Raye the coating is gone from all. Of the 44 piles by Peace & Beardsley 35 are entirely sound; 4 had broken coverings, and the 5 piles coated without burlap are almost entirely bare. The broken covering both on the Shay and the Peace & Beardsley piles has the appearance of having been struck a blow or jammed, but whether caused intentionally or by accident is not known; but one pile on the south side of the pier bears evidence of having been purposely injured.

June 25, 1884.—All of the piles described in the above list were examined by the Chief Engineer and Col. George H. Mendell, Corps of Engineers U. S. A. None of the processes showed permanence nor any better result than the bark would have given, and most of them were in worse condition than the unprotected piles. The pipes covering Von Schmidt's piles were cracked and one section on the south pile was broken; this was probably due to spring of the wharf and the protection being too stiff. McKeon's piles were almost entirely unprotected and the coverings hanging only to the upper part of the pile. Peace & Beardsley's pile showed tolerably well, but there was no adhesion between the pile and the covering. The same thing was true of the Shay (or Duffy) process. Eucalyptus and cedar were about the same as when put in to all outside appearance.

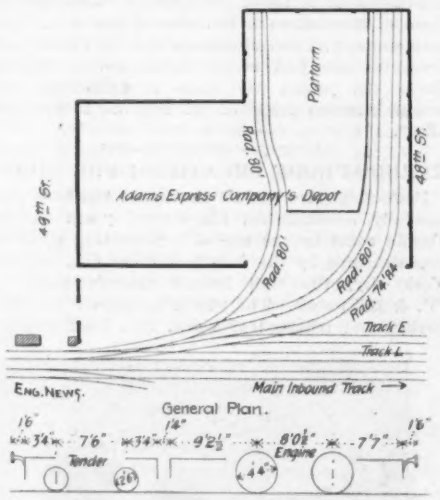
Mr. Holmes gives the following particulars as to the use of the P. & B. method of protection:

During the last three or four years the board has used in constructing wharves a great many piles prepared with paraffine paint, and the result so far has been quite satisfactory. This method consists in barking that portion of the pile which is exposed to the attacks of the teredo and limnoria, painting it with paraffine paint and covering it with burlap, saturated with the same paint. To protect the covering, redwood battens ½ × 3 or 4 ins. are closely nailed over it. The advantage of this process is, that the material is applied cold and is very adhesive and elastic.

The introduction of the P. & B. method of pile protection for work in the South Atlantic and Gulf states has been placed in the hands of Mr. Ellis D. Thompson, C. E., of Bound Brook, N. J., to whom application should be made by any one desiring further information.

SHARP CURVES IN RAILWAY TRACK.

A question which periodically comes up for discussion is, What is the radius of the sharpest curve on a standard gage track over which trains can be operated without difficulty? We are indebted to Mr. Walter Katte, Chief Engineer of the New York Central & Hudson River R. R., for a plan showing three spur tracks which he has recently had to lay to the new freight warehouse of the Adams Express Co., just erected on the east side of the Grand Central Station yard, New York, between Forty-eighth and Forty-ninth Sts. These curves are of 75 ft. and 80 ft. radius on the center lines, and they are found to be entirely satisfactory. The cars used are the standard baggage cars, 50 ft. long. The engine used is one of the ordinary four-wheel yard switchers, with a four-wheel tender. The only alteration made to adapt this engine to these curves was to lengthen the drawbar between the engine and tender, so as to separate their end frame bars by a distance of 1 ft. 4 ins., which admits of their taking the curves with perfect ease. The tires are 5½ ins. wide, with a 4-in. tread, and the flanges are 1 in. high. The wheel gage is 4 ft. 5½ ins. back to back of tires, and the track gage is 4 ft. 9 ins., or ½ in. wider than standard. The driving wheels are 4 ft. 4 ins. diameter, with a wheel base of 8 ft. 0½ in.; and the tender wheels are 2 ft. 6 ins. diameter, with a wheel base of 7 ft. 6 ins.



Sharp Curves in Yard of Grand Central Station, New York City.

A diagram of the wheel base of the engine is given on the accompanying cut.

With the exception of the 50-ft. curve of the United States Military Railways, noted below, these are probably the sharpest curves that have ever been operated in regular service on any standard gage road. In this connection we reprint from Wellington's "Economic Theory of Railway Location," a table of the sharpest curves in regular use on standard gage tracks, together with a description of the 50-ft. curve of the U. S. Military Railways which was given by Mr. C. L. McAlpine in discussing a paper by Mr. C. Whinery on "Theoretical Resistances of Railway Curves" (Trans. Am. Soc. C. E., 1878).

Sharpest Curves on Standard Gage Tracks.

Road.	Locality.	Sharpest curve.—Radius, ft.	Deg.	Min.
N.Y., New Haven & Hartford	Springfield, Mass.	410	14	
Lehigh & Susq.	Upper divisions	383	15	
" "	Stony Creek	320	18	
" "	Butler Branch	310	18	32
Balto. & Ohio	Harper's Ferry, Md side	400	14	22
" "	Ilchester	375	15	20
" "	Harper's Ferry, Va. side	300	19	10
" "	Y for consol. eng.	136	43	
Oroya Railway	In Peru	395	14	32
Virginia Central	Over Rockfish G'p Tunnel	300	19	10
" "	Over R'ckfish Gap Tunnel	238	24	15
Penn. R. R. tr'cks.	Centennial Gr'ds.	300	19	10
P'tsb., Ft. W. & Ch.	Pittsburg	246	23	30
Can. & Rock'w'y.	Brooklyn	175	33	15
Brooklyn, Bath & Coney Island	"	55 to 125	..	..
Manhattan Elev.	N. Y. City	90, 100, 103.5, 125, 150	63	
Petersburg, Va.	U. S. Milit'ry Ry.	50	..	
N. Y. Central	Gr'nd Cent. Yd.	75 and 80	..	

Petersburg and Richmond, Va., fell into the hands of the Federal troops near the close of the war. The base of the latter for many months had been at City Point, on the James River. Early one morning imperative orders were received to run the trains of the United States Military Railways into Petersburg with the least possible delay. This was done by noon of the same day, under circumstances that would be most interesting, but foreign to the subject under discussion. This order was followed up by another—that railway communication with Richmond should be effected at once. The railway bridge at Petersburg, over the Appomattox, had been burned. No connection at that place had ever been made in place times, and the first examinations showed that heavy excavations, etc., requiring time (for which the department never made allowance), must be made, before any reasonable connection with the Richmond line could be effected. This drove the engineer in charge into the apparently inadmissible curve adopted.

Contrary to the advice of trackman and bridge-builders a sharp curve was laid out of more than 100°, with a radius of 50 ft., on what was to become the main line. The curve was on trestlework, and the outside posts were framed 8 ins. longer than the inner ones. The ties were of sound white pine, 3 ins. in thickness, and the rails were double spiked. Two guard rails were used, also double spiked. The locomotive engineers generally condemned the bridge and curve at first sight after completion, and a strong prejudice was created against it. But the writer selected the worst curve following engine in the service, the "Government," and ordered her to make the first trial. Walking backward, and in front, as this engine slowly made its way, it was easy to perceive her action on this sharp curve. A little pressure on the outer rail seemed to drive the wheels (both of the trucks and drivers) down onto the inner rail, and demonstrated practically what had been intended, that the trains must be passed through the curve at greater speed. Thereafter, when the locomotive men became accustomed to the curve, the speed through it was usually from eight to ten miles an hour. A very large traffic passed over this curve for months afterward, supplying the armies of occupation in Richmond, and at other points to the southward, and no accident or trouble whatever was experienced at the place in question.

THE EAST PROVIDENCE STAND-PIPE FAILURE.

In our issue of Jan. 25 an account was given of the stand-pipe failure on Jan. 19 at East Providence, R. I. Below are given letters by Prof. J. M. Porter, Assoc. M. Am. Soc. C. E., of Lafayette College, Easton, Pa., and Mr. Samuel M. Gray, M. Am. Soc. C. E., of Providence, R. I., Chief Engineer of the new water-works at East Providence. Both letters were written at our request and that of Mr. Porter is accompanied by three illustrations. Mr. Porter writes as follows under dates of Jan. 29 and Feb. 3.

The accompanying sketch and photographs show the condition in which the writer found the East Provi-

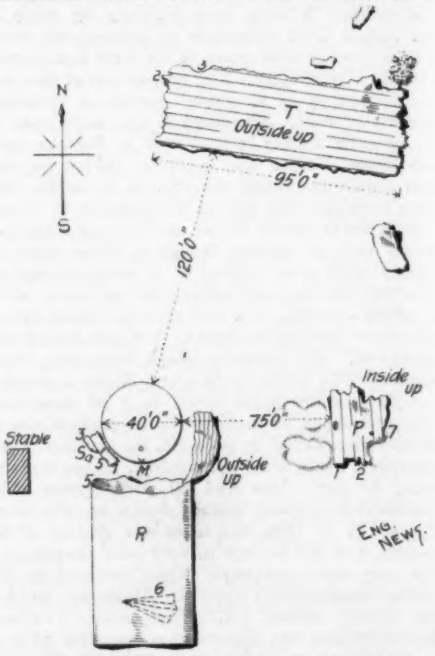


Fig. 1 Sketch Showing Position of Various Parts of East Providence Stand-Pipe After the Failure of Jan. 19.

dence stand-pipe shortly after its failure: The relative positions of the several shattered portions and the character and form of their fracture lead to the following conclusions: The initial rupture evidently occurred in the lower 45 ft., about 18 ft. southwest of the manhole, near S, Fig. 1, probably in the second ring. These lower rings, being torn free from the top rings and the ¾-in. angle connecting them to the bottom, were straightened out and carried away with their thicker courses in advance. The portion P, strik-

ing a small rise in the ground, separated from T, and was found inside up 75 ft. to the west of the foundation, with its edge marked 7 buried in the ground. This fragment, P, composed a portion of the five bottom rings, and contains the manhole originally at M. The portion T is nearly nine rings wide and approximately 95 ft. long. It was found about 120 ft. north of the base, outside up, with its thicker courses to the north, as shown in the view, Fig. 2. This portion is by far the largest of the fragments. Farther north were found smaller fragments of the bottom ring. The portions T, P, S, together with other small and shattered fragments, once formed about the nine lower rings, or 45 ft. Points 2 of P

FIG. 2. VIEW OF WRECKED PIPE.

and T were found to coincide exactly. The small fragment S, found near the masonry, gave indications of having simply fallen over. It comprised a portion of the first and second rings. Points 1 of S and P fit perfectly, as do points 3 of S and T. Point 5 of S gave conclusive evidence of having received a hard blow from 5 of R, Fig. 1, but not until S had fallen past a horizontal position. As most of the fractured rings were thrown to the north by the reaction of the water, it was but natural that the remaining top rings should fall to the south; such was

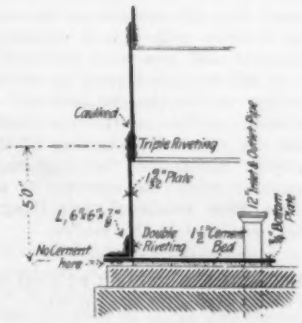


Fig. 3. Section Showing Bottom of Stand-Pipe and Top of Foundations.

the case, as shown by the diagram, portion R. The conical roof, made of iron, was found badly bent, but without many fractures inside the pipe at 6 of R. The top of the north end of R was opened up and laid outside up, as shown on the diagram and in Fig. 2. The stable to the west of the base was completely wrecked, even to the foundation walls.

A few barrels were found inside of the pipe near the top, some on the foundation and some on the ground near the base, as shown in Fig. 2. They had been used as a float during the construction of the top and had been left there by the contractors.

The direct cause of the failure will probably remain unknown. It may have been due to the ice that had formed at the top, causing the pipe to be converted into a closed cylinder; the ice may have fallen, or damage may have been done during the wind storm which occurred last September; but most probably the failure was caused by the material of which the pipe was built, steel. The writer cannot believe that steel is the material for stand-pipes when built with lap joints. The heating of one corner of a steel plate for the necessary scarfing and the local heating the joint must receive during erection in order to draw it up tight, is certainly not very beneficial to any material like steel. The most, if not all, of the stand-pipes that have failed have been built of steel—not a very good record for this material in that capacity. However, letting the material be what it may, or not, ⅞-in. plates is about the maximum thickness that can be riveted in the field by hand. Fig. 3 is a section through the lower part of the structure, to the right of the inlet and outlet pipe, showing the method of riveting, the bottom angle iron and the top of the foundation. The cement on the outer edge was gone, as indicated in the sketch. In some places the cement bed was 6, 8 and 12 ins. from the outer edge and the superintendent of the water district made statements from which I inferred that no cement had ever been placed under the edges. The rivets were driven and the calking was done from the outside. The heads were mashed down, no button set being used. The rivets used here were 1⅛ ins. in diameter. No anchorage of any kind was used and none was needed.

Under date of Feb. 2, Mr. Gray writes as follows:

Replying to yours of Feb. 1, which is just received, asking for an opinion as to the cause of the accident that resulted in the destruction of the stand-pipe at East Providence, I have to say that I cannot even as much as comment on the cause as yet. There is no evidence to show that the accident was due to poor material or inferior workmanship. On the contrary, both material and workmanship appear to have been excellent.

The stand-pipe was designed to have a factor of safety of very nearly six for the lower rings or courses, five for the middle, and four for the upper rings. No ring had a factor of safety less than four. In short, the stand-pipe was built to stand the strain of static pressure from four to six times greater than it would be normally subjected to. It is interesting to notice that the pipe did not burst at the point where it had the least factor of safety, but where the factor of safety was greatest.

The foundation rested on solid ledge and the foundation remains to-day intact as perfect as the day it was built.

The specifications call for American rolled steel which would stand 60,000 lbs. tensile strain to the square inch. The metal was very uniform in strength, as was shown by tests made from samples taken from some forty sheets selected at random. The least tensile strength of any specimen was 59,540 lbs. to the square inch, the greatest being 64,880, the average being upward of 62,000 lbs. to the square inch.

It is at present difficult to substantiate any theory by the facts as far as they are known. The destruction of the stand-pipe was complete. The lower section of the stand-pipe for a width of upward of 40 ft. was literally torn asunder, straightened out and thrown a distance of upward of 150 ft. from the stand-pipe. This piece was about 120 ft. long and weighed upward of 60 tons. Fragments of the lower section of the stand-pipe, weighing 12 tons and less were buried in various directions. The upper section of the stand-pipe of about 75 ft. in length fell intact at the foot of the structure. Parties living near the stand-pipe represent the "explosion" as sounding like a mammoth blast from a ledge.

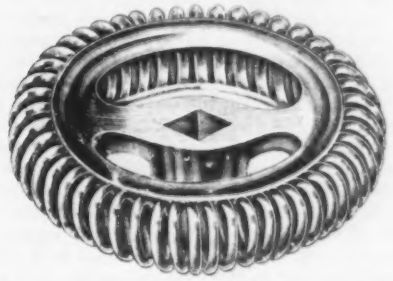
I am investigating the matter and hope I may be able to discover the cause of the accident. At the present time it seems a mystery.

A further letter from Mr. Gray dated Feb. 5, has been received since the above was put in type. It is as follows:

In reply to your inquiry of Feb. 2 relating to report that "the cement bed under stand-pipe had been broken out prior to failure," I have to say that there is not the slightest shadow of truth in the report. The foundation remains intact and in every way, shape and fashion as perfect as the day it was laid. Any statements to the contrary are untruthful and absurd.

A COOL HAND-WHEEL FOR STEAM VALVES.

The accompanying cut shows a new hand-wheel for steam valves, recently put on the market by Mr. W. F. Greene, of Troy, N. Y. The circumference of the wheel is a continuous coil of steel wire, which exposes so large a surface to the air that it does not get hot as do metal wheels, and



is cheaper and more durable than the wooden rims ordinarily used on steam valves. Stove griddle lifters made on the same principle have long been in use. The corrugated surface which the wheel offers to the hand enables a firmer grip to be taken than can be obtained on an ordinary wooden wheel.

NOTES BY RAIL.

New York, Lake Erie & Western R. R.—This road is operated on the block system for practically its entire length between New York and Chicago, 986 miles. From New York to Hornellsville (and Buffalo) the line is double track, laid mostly with 80-lb. steel rails, with broken suspended joints spliced by 30-in. six-bolt angle bars. There are 16 ties to a rail, and broken stone ballast is largely used. On the New York, Pennsylvania & Ohio and Chicago & Erie divisions the rails weigh 65, 70 and 80 lbs. per yd., and are laid with broken suspended joints spliced by four-bolt angle bars. The track is in good conditon and the ballast neatly kept. Slag, gravel and cinders are mainly used for ballast. With slag the cross-section, size and method of tamping are about the same as with broken stone, and Mr. A. Mordecai, Chief Engineer, states that it is found to be a very satisfactory material, fully as durable as stone. The furnace companies are glad to give the railway company the slag on cars at their furnaces. All switch-stands have double targets, showing red or white according to the position of the switch, and the main line switches have tall switchstands with the targets about 15 ft. above the rails. Derails in side tracks are operated in connection with these switches. On the New York division the road-crossing signs are large and conspicuous, but on the western divisions they are small cast iron signs on posts. Wooden slat cattle guards are used on these divisions. Flat stone posts are set to mark each mile, half mile and quarter mile, the two former having figures cut in them, and all have the upper part painted white and the lower part black. Tile drains are laid in some wet cuts, collarless red

tile pipe being used. For fencing, twisted wire (four or five wires) is extensively used. Bridges have open floors, with inside iron and outside wooden guard rails, the former being extended well onto the approaches and brought together between the rails. On the section-house at Saegertown, Pa., was noticed a large sign with "Premium Section" in large letters, and these signs occur every hundred miles. South of Corning, N. Y., a new double-track iron bridge of three spans of 148 ft. each, over the Chemung River is being erected by the Union Bridge Co.

The signal and interlocking plant at the Jersey City terminal station was described and illustrated in our issue of May 23, 1891, and from New York to Turners, 47 miles, the road is equipped with the Sykes lock-and-block system. The plant was erected by the Union Switch & Signal Co., and has been in operation since the autumn of 1886. Bracket posts are placed at main line switches and the balance levers and counterweights are inclosed in a box at the base of the post. Between Turners and Salamanca, 367 miles, the bell code system of signaling is used. Most American railways, however, are chiefly interested in single-track blocking, hence especial attention is attracted to the Mozier block signal system, which is in use on 553.7 miles of single track between Salamanca, N. Y., and Hammond, Ind., and on 22 miles between Pymatung and Youngstown, where main line passenger trains make a detour through the Mahoning Valley. This is all operated under the direction of the train dispatchers, as described fully in our issue of May 11, 1893. Passenger trains are run under the absolute block system, but freight trains are run under the permissive block system, a third position of the semaphore (inclined upward from the post and showing a green light by night), allowing the enginemen of freight trains to proceed with caution and warning them that the block is not clear. The rules for operating were given in the article above referred to. The equipment is simple and economical, and therefore meets the requirements of many American roads which have to handle heavy traffic over single-track lines, but cannot afford the expense of an elaborate and complicated system of block signaling. The Mozier system has been found very satisfactory on the Erie and other roads, and about 1,000 miles of road are now equipped with it. The Erie R. R. operated its heavy World's Fair traffic last summer under this system without a single accident to passenger trains. Two styles of signals are used on the Erie R. R. with this system, and in each case the lamp is on top of the post. The first consists of a single semaphore solid post on each side of the track, and the second consists of a hollow post carrying both semaphores. The latter form is considered preferable by the manufacturers, as the lamps burn better and it often occurs that only one good location can be found at a station, the other side of the track being obscured by trees, buildings, water tanks, etc. The running faces of the semaphores are painted red with a white stripe, but it would seem as though white would be a more distinctive color for the posts than the dull ochre now used.

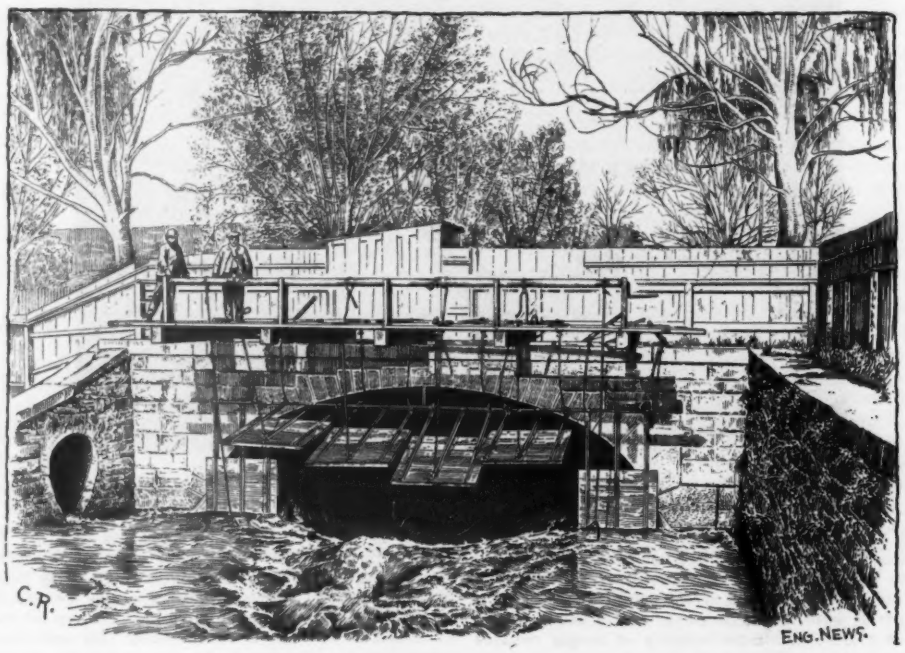
Eight-wheel switch engines, with saddle tanks and rear coal bunkers are used in some yards, and these engines are so handy and convenient that it is somewhat surprising they are not more generally used in this country, as they are abroad. It is not a difficult matter to keep the bunkers full, and the engineman can make his couplings with much less damage and difficulty than when he has a tender between the cab and the car. Ten-wheel engines are used on the through passenger trains, and so many of the express engines on this and other roads have the extended wagon-top boiler, leaving but one ring of cylindrical barrel, that one is inclined to wonder why the boiler was not made with a straight top and of the uniform diameter of the present wagon-top.

Chicago & Northwestern Railway.—This is one of the few American roads which, on double track, makes its trains keep to the left. The main line from Chicago to Milwaukee, 85 miles, is double track, except between Racine and Kenosha, 12 miles. This piece of track has 65-lb. rails laid with suspended joints (broken on curves, and square on tangents) spliced by four-bolt angle bars and having 18 ties to a rail, with gravel ballast. This section will probably be doubled-tracked this year. The double track is laid with the 80-lb. rails and bridge joints described and illustrated in our issue of Sept. 7, 1893. A considerable portion of the track has slag ballast, covered with a fine sandy gravel, the surface being made level with the top of the ties and extended about 8 or 12 ins. beyond their ends, but the gravel makes a dusty track. The old track was laid with slag, but the new is laid with gravel, and in bringing the old track up to grade a light dressing of gravel was used. The slag has the advantage of checking persons from walking on the track. A considerable amount of work has been done on this division during the year, including masonry ends to culverts and to drains carrying the side ditches under highways at crossings. A variety of metal and wooden cattle guards are used. Plate girders are used for short bridges and open culverts, and have open floors.

The Madison division, between Milwaukee and Madison, Wis., 82 miles, is single track, laid partly with Cambria rails (rolled in 1878), spliced with four-bolt angle bars 21 ins. long. The rails are laid with square suspended joints, but Mr. Kerwin, the roadmaster of the division, while approving of square joints, would prefer to lay a tie under each joint, considering that the track would thus be kept in better surface with less work. The rails weigh 60 lbs. per yd., and have been in service for 11 years, but 72-lb. rails are now being laid in some places. The ties are mainly of cedar on the tangents and some of them have been in service for 11 years, without showing excessive cutting by the rail flange. White oak ties are used on curves, and to some extent on tangents, owing to their greater hold upon the spikes. No tieplates are used. The Verona and National nut locks are mainly used, and several other makes are being tried experimentally, including the Van Dusen nut lock, which is of rubber inclosed in iron and has the advantage of keeping the nut well away from the splice bar, so that the wrench can get a good hold of it. The cattle guards have pits and beveled ties, and footguards are used at frogs, switches and guard rails. The track is ballasted with gravel obtained along the line, but the material is very coarse, containing large stones which have to be removed.

The company has adopted the Hall automatic block signal system on its busy lines entering Chicago, and uses the wire circuit principally. It has this equipment on 26 miles of the Galena division, 35 miles on the Wisconsin division, and 35 miles on the Milwaukee division, in each case extending from Chicago to the end of the suburban limits. Through the city the signals are carried on iron bridges spanning the tracks. Mr. E. C. Carter, Principal Assistant Engineer, states that the system has also recently been applied on ten miles of line extending from Milwaukee to South Milwaukee, and this additional contract shows that the company has found the Hall system satisfactory. Junctions equipped with interlocking plant have semaphore signals, the home signal painted all red, and the distant signal having a forked green arm with a forked red stripe edged with white. Switchstands at switches operated by hand have single targets, although the double target, showing a positive signal in both positions of the switch, is generally considered to be the best arrangement. Woven wire fencing is extensively used, and through the Chicago suburbs it is about six or eight feet high, the posts having a horizontal wooden rail about 3 ft. from the ground, and a barbed wire being laid along the top of the posts. At yards, in the winter, posts are set up, to each of which is hung a broom and a shovel for use in clearing snow from the switches.

Interesting details of practice are to be met with on nearly every railway, and one such detail observed in the Chicago terminal station of this road was the method of controlling empty trains while being backed into the station. A loose piece of brake hose is fitted with a hose coupling at one end, and a cock and iron hook at the other. A brakeman on the rear car couples up this pipe and hooks the loose end to the platform rail. As the train is backed in he rides on the rear platform and can control the speed and stopping of the train without relying entirely on the engineman, who often cannot see when the rear car is near the bumper. The Ellis bumping posts (Eng. News, Oct. 6, 1892) are used in this station.



VIEW OF TIBER CREEK SEWER FLUSHING GATES, WASHINGTON, D. C.

THE TIBER CREEK SEWER FLUSH GATES, WASHINGTON, D. C.

The following description of the method adopted to flush a large sewer at Washington, D. C., was sent us by Capt. Chas. F. Powell, U. S. A., Engineer Commissioner of the District of Columbia:

The Tiber sewer of Washington, so called by reason of its occupancy of the upper portion of the bed of the old-time Tiber Creek, collects storm-water from an area of 1,473 acres and sewage from an even more extended district. Its present outlet, diverted from that of the original Tiber, lies in the course of ancient James Creek, long since occupied as a canal site. It thus happens that the Tiber sewer finds its discharge into the eastern branch of the Potomac River through a walled channel, 57 ft. wide, 7,200 ft. long and with a mean depth of 4 to 6 ft. below low tide level. The sewer itself is also subject to tidal flow for nearly 5,000 ft. of its length above the canal. This por-

tion of the sewer structure consists of a plank bottom 29 ft. wide, submerged 2 ft. at ordinary low tide, battered side walls 3 ft. high, and a flat segmental arch of 30 ft. span, built of brick masonry, the greatest inside height being 10 ft. 10 ins.

The operation of this outlet, when established in 1875, appears not to have been offensive; but in recent years the extension of building improvements in the tributary territory, as well as the reception of sewage from systems heretofore discharging elsewhere, besides the more full occupation of the locality of the canal for dwellings and business purposes, has directed attention to it as a serious public nuisance and a source of disease. During long periods of small rainfall the sluggish flow of the sewage was insufficient to cleanse it and at all times the flow was impeded by the presence of scows and small craft discharging cargoes upon the low canal banks.

A complete remedy for this unhealthful condition was proposed in the report upon the Sewerage of the District of Columbia (1890) which suggests the filling of the canal upon the completion of works for intercepting the sewage and drainage which it conveys, but as these works are not yet under construction the application of this remedy will be deferred for a number of years.

Capt. Chas. F. Powell, upon assuming the duties of Engineer Commissioner of the District of Columbia, directed his attention to improving the condition of this stagnant waterway and projected various methods by which it could be effectively flushed, among which was the building of flushing dams to impound either the tidal water or the sewage itself. The last method was considered of sufficient promise to warrant further study. It was at first deemed expedient to erect, either near the upper end of the canal, or within the sewer, a movable dam composed of small wickets, but this type of structure gave place to a design for simple gates hinged to a common horizontal axis and closing upon the vertical face of masonry with which the sewer terminates.

As constructed and shown in the accompanying illustration, an iron hinge axis is supported by bolts cemented in the wall, upon which swing six gates. When closed these gates are held in position by two bolts in each gate engaging a bracket made of angle iron and fastened to the floor of the sewer. A projecting platform over the mouth of the sewer supports a windlass, which is used in hoisting the gates after they have been opened by disengaging the bolts.

The gates are closed when the tide begins to flood and open about 45 minutes before low tide. At the time of discharge the difference of head obtained is 3½ ft. and the estimated quantity of sewage set free 4,000,000 gallons.

The gates are operated twice each lunar day except at times of heavy rains or storm tides. The result of each operation is to cleanse the lower part of the sewer, to strongly agitate the water of the canal near its head and to make a considerable current throughout its length. The effect is a very noticeable betterment of the condition of the canal. The gates cost less than $600. They were designed in the office of the superintendent of sewers and principally by Mr. C. B. Ball, Assistant Engineer.

The curve of surface variation during a period of 12 hours was determined on Nov. 12, 1893, by means of a self-registering gage located in the sewer 3,800 ft. from its outlet into the canal. The gates were opened about 3 p. m. and in about a half hour the surface level fell 3 ft. At 10 p. m. the surface had risen to the 4-ft. point.

FRANKEL'S DEFLECTION METER FOR MEASURING BRIDGE VIBRATIONS.

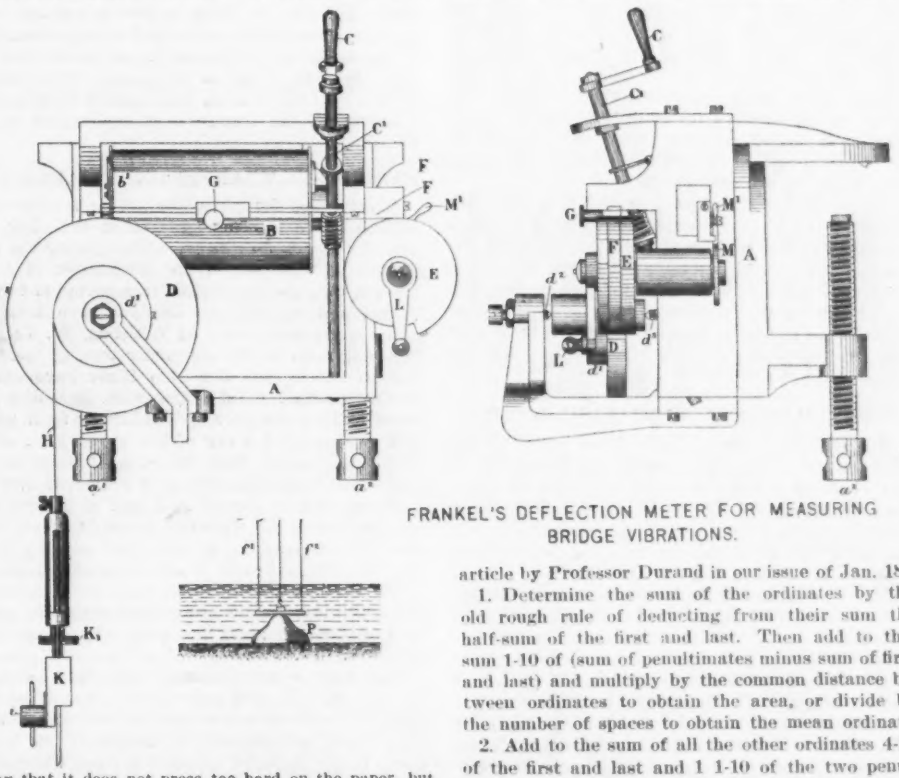
One of the chief difficulties in measuring the deflection and vibrations of bridges under moving loads is that of providing the requisite fixed points, especially when the bridge crosses a river at any great height above the water, or where the water is deep. If the stream is navigable the difficulty is increased, and in any case the erection of a trestle or even the driving of a single pile entails trouble and cost often disproportionate to the value of the records obtained. With the view of doing away with this fixed trestle work or column the Frankel deflection meter, which is illustrated herewith, has been designed. In this apparatus the fixed points necessary for the measurements of the vibration are established by means of a cast iron weight weighing about 33 lbs. We are indebted to a recent number of "Indian Engineering" for the illustration and the following description:

The apparatus consists of a frame, A, which can be fixed by means of the pinch screws a1, a2, to the member of the bridge to be examined. Frame A holds the movable disks Dd', placed between the pointed screws d2 and d3. A small steel band, F, attaches the larger disk, D, to the scriber, G, and the spring barrel, E, the steel band being kept continually tight by a spring inside the barrel E. Under the scriber and parallel to its direction the revolving paper cylinder B is placed. This cylinder is connected with a worm wheel, and can be turned by means of screw gearing.

Before using the apparatus, the cylinder B is covered with specially prepared paper. For this purpose the clip at b1 is loosened, and the paper, with the prepared side outermost, laid on as taut as possible. Care, however, must be taken to lay both ends of the strip of paper one over the other under the clip, so that they are held fast by it. To make this easier the driving screw is to be slacked off by pressure on the handle C, and the cylinder B proportionately turned.

The scriber must be fixed in its holder in such a way that it does not press too hard on the paper, but writes just sufficiently clearly. This regulating of the scriber is easily done by adjusting the nut of the screw on the holder of the scriber. It is better to use aniline pencils as scribers, such as are supplied with the apparatus.

To use the apparatus it is fixed by means of the screws a1 and a2 to the bottom chord or to a specially selected vertical of the bridge to be examined. After the end of a sufficiently long wire has been attached to the weight, the latter is let down to the bed of the river by means of two cords. Care must be taken in letting down the weight that the cords do not get entangled with the wire and that the weight rests on the river bed as nearly as possible perpendicular to the fixed apparatus. If the stream is flowing fast, the weight must be thrown proportionately upstream as it will be carried somewhat downstream before it touches the bottom. Next, the little steel band H is hung on the disk d1, the upper end of the wire is put through the hole bored in the clamp K, the wire drawn as taut as possible, twisted once round the screw 1, and, lastly, pulled tight. By turning the handle L the wire receives a tension in proportion to its length, and the scriber, G, by turning the screw K1 such a position that it does not touch the limits of the space in which it works in recording the deflection. When everything is duly and carefully prepared, the hitherto stationary scriber is made to touch the paper cylinders, and on approach of the rolling load the cylinder B is revolved slowly by turning the spindle C1 as evenly as possible. The scriber will then record a clearly intelligible diagram of the deflection of the beam in the ratio of 1 to 2.



FRANKEL'S DEFLECTION METER FOR MEASURING BRIDGE VIBRATIONS.

Before taking off the apparatus, the tension of the spring in the barrel E is first loosened, the handle put on firmly, the pawl, by pressure on M, brought out of the ratchet wheel M, and the handle L turned slowly backward until the tension of the spring inside the barrel E is quite loose. Then only is the connection of the apparatus with the weight at the bottom of the stream to be undone. Before using the deflection meters it must be ascertained that the attachment of the scriber is free from rust and that the graduated disk will turn easily.

In our issue of April 28, 1893, we illustrated a device for recording the vibrations of ships, which could probably also be applied to recording bridge vibration.

PROFESSOR DURAND'S NEW RULE FOR INTEGRATION.

The two wordings of this new rule which we gave in our issue of Jan. 25 each contain an error of form, for one of which we are responsible and for the other our correspondent. Reworded correctly they should read as follows; (the original formula having been given and demonstrated in an article by Professor Durand in our issue of Jan. 18).

1. Determine the sum of the ordinates by the old rough rule of deducting from their sum the half-sum of the first and last. Then add to this sum 1-10 of (sum of penultimates minus sum of first and last) and multiply by the common distance between ordinates to obtain the area, or divide by the number of spaces to obtain the mean ordinate.

2. Add to the sum of all the other ordinates 4-10 of the first and last and 1 1-10 of the two penultimates. Multiply the sum thus gained by the common distance between ordinates to obtain the area or divide this sum by the number of spaces to obtain the mean ordinate.

These two rules differ only in form, and in that but slightly, and give the most accurate expression of area which is possible by any formula whatever from the given notes, viz.: Equidistant ordinates. Substituting areas for ordinates the rule applies as well to the determination of volumes from equidistant sections as to the determination of areas from equidistant ordinates.

INSPECTING STEAM ENGINES AND BOILERS IN MASSACHUSETTS.

An investigation of steam plants in Boston and vicinity has been made under direction of the Chief of the District Police. The report of the inspector gives an interesting revelation of the number of dangerous boilers that are in daily operation. The inspector was appointed in August. Up to Nov. 1 he had examined 171 boilers in which he found 486 defects, of which 114 were considered dangerous.

At one establishment the inspector found the engine running and the boiler supplying steam to it, but no engineer was in sight. The inspector tried the lowest gage cock and found no water, and

then hunted up the engineer, finding him on the roof of the boiler-house engaged in patching it. He grumbled considerably about coming down, and when he found no water by the lowest gage cock started the injector as coolly as if it were a common thing to find no water there. It was ten minutes before water appeared at the lowest cock. The inspector continues as follows:

> The tubes were leaking very badly, and those that were not leaking had been stopped up by rust. The dry sheet had been burned off in places and the setting had sprung away, so that the fire came up directly to the up-take without going under the boiler, at the same time exposing the rivets of the first course to the direct action of the flame, with nothing whatever to protect them.
>
> The engineer claimed that he blew water from the boiler quite frequently, yet the most strenuous efforts of the engineer and myself could not start the blow-off plug, showing conclusively that it had not been used for a very long time. The setting was filled with large gaps and holes, and the general appearance was one of extreme neglect. . . . . This boiler is on one of the crowded thoroughfares of South Boston.

Steam heating boilers used in public school buildings and boilers used in hotels are frequently in charge of men entirely incompetent and with no appreciation of their responsibilities. Safety valves and blow-off valves were found in many instances wholly inoperative, and serious leakages and defective settings were common. The report recommends that the laws be so amended as to require the inspection of all uninsured steam boilers, and to require the licensing of all persons placed in charge of boilers. Contrary to general belief, the inspector found that neither on the part of those in charge of steam plants nor those owning them was much opposition found to the plan of requiring an examination to be passed and a certificate of competency filed to entitle a person to be placed in charge of a steam plant.

In examining steam engines the inspector took pains to find what measures were adopted to guard against flywheel explosions from the racing of the engine. In several instances he found the safety stop on the governor disconnected, the engine thus being left free to run away in case of breakage of the governor belt. The fact appeared to be that the engineers so misusing their engine did not know what the safety stop was for.

THE RADDATZ SUBMARINE BOAT.

In our issue of Sept. 21, 1893, we described the Holland submarine boat, which was favorably reported on by a board of naval engineers for adoption by the United States. Since that time Secretary Herbert's annual report has appeared, throwing cold water on submarine boats generally—a treatment which such boats are expected to stand without injury in the literal sense, though whether their promoters can endure the ducking remains to be seen.

Inventors are still busy on the problem, however, and are not likely to abandon it until it is successfully solved. The latest experiments in this direction have been made at Oshkosh, Wis., by Mr. Richard Raddatz, a mechanical and electrical engineer. From information which he has furnished us we learn that he has constructed a submarine boat 50 ft. in length, with a cross-section 4 ft. wide and 7 ft. 6 ins. high at the center. This section extends each side of the center for a distance of about 8 ft., and then the vessel tapers to a sharp point at each end. The shell of the boat is made of 5-16-in. steel plate with double-riveted seams, and is strengthened and stiffened internally by angle irons. The vessel was designed by Mr. Raddatz to endure with safety the pressure due to a depth of 500 ft. A 24-in. propeller wheel of 36-in. pitch, driven by a street railway motor absorbing about 10 HP. of electric energy furnishes the motive power of the vessel. At the stern are also the rudders for steering the vessel in a horizontal plane. The inventor claims great perfection for his method of sinking the vessel and returning it to the surface, but he gives no information as to what his method is except to say that the vessel is not submerged by admitting water into the ship nor by the use of vertical screws or horizontal rudders. One's curiosity is strongly aroused as to how such a vessel can descend in the water without either being made heavier than the water, so as to sink, or being forced down by reaction against the surrounding water.

The front end of the boat resembles Captain Nemo's famous "Nautilus," in having a solid steel beak, which Mr. Raddatz says "could become a dangerous weapon of offense should it ever be desirable to use it as such." There are no other warlike weapons attached to the vessel at present constructed, however and it is intended to use her in the peaceful work of examining submerged wrecks and making submarine surveys. The boat is navigated by one man, who obtains a lookout on his surroundings through a conning tower 2 ft. in diameter on top of the hull. The removable top of this tower furnishes the sole means of entering and leaving the vessel. In the conning tower is a searchlight of 2,000 c. p., current for which is furnished by the same storage batteries that supply the current for the propelling dynamo. It is expected to utilize this searchlight in taking submarine photographs.

In most submarine boats, fresh air is furnished by storing compressed air in reservoirs, but Mr. Raddatz again imitates Jules Verne by "revivifying" the air, thus using it over and over again. He states that at a cost of about 10 cts. per hour the air can be maintained in condition for respiration for a period of 24 hours.

Tests of the vessel were made at Oshkosh during November, and are said to have shown satisfactory results. The tests are to be resumed in the spring, and the inventor invites any one interested to attend these tests, and satisfy himself as to the merits of the invention. After the tests are concluded the vessel is to examine some sunken wrecks in Lake Huron, and is then to undertake a survey of the lakes, at whose expense is not stated.

PASSENGER TRAFFIC ON A CABLEWAY.

A cableway for passenger traffic is the novel scheme which is being agitated at Wheeling, W. Va. As our readers know, cableways for the conveyance of materials in the construction of dams, bridges, etc., and for freight transportation in very rugged and mountainous districts have been for years in extensive use. At Wheeling, W. Va., the high toll rates of the companies owning the steel bridges which span the Ohio River have caused much opposition and dissatisfaction. It is now proposed to span the river by a cableway from which will be suspended a car with a capacity for 20 or more passengers. The Wheeling "Intelligencer" states that local engineers have estimated that the cableway can be erected at a cost of $10,000 and the trip across the river can be made in one minute. The topography is such that passengers on the Wheeling side can be landed near the ground level, while on the other side they would be landed on a platform in the tower supporting the cableway, and would reach the ground by an elevator or stairway.

That such a transportation line could be made at least as safe as a cable incline or a passenger elevator, both of which rely on the strength of wire ropes, will probably be admitted; but it appears rather doubtful whether a large fraction of the traveling public would patronize a mode of conveyance which would look so dangerous to the uninitiated. The swinging of the car on a windy day, and even the ordinary oscillation due to its passage at high speed over the cables, would be an objection to quite a large class of people. At the same time the very novelty of the scheme and the spice of adventure in the ride across might attract no small number of patrons, especially at the very low fare, 1 cent per trip, which is proposed; and the cost of the structure is so small that a moderate amount of traffic would pay a handsome return on the investment.

We may note in this connection that a bridge has recently been completed in Spain on a somewhat similar principle. The trolley from which the car is suspended runs on an overhead truss instead of on a suspended cable, however.

PERSONALS.

Mr. Alexander Potter, civil engineer, New York, has opened a branch office at Pittsburg, Pa.

Mr. A. N. Towne has not resigned as General Manager of the Southern Pacific Ry., as had been reported.

Mr. F. J. V. Skiff, who was Chief of the Mines and Mining Department of the World's Columbian Exposition, has been appointed Director-in-Chief of the Columbian Museum.

Mr. H. A. Boomer has been appointed Division Superintendent of the Toledo, St. Louis & Kansas City R. R., with headquarters at Frankfort, Ind., vice Mr. C. N. Pratt, resigned.

Mr. J. W. Schaub, M. Am. Soc. C. E., has resigned his positions as Chief Engineer of the Pottsville Iron & Steel Co., and General Manager of the Pottsville Bridge Works, to take effect March 1.

Mr. Isaac D. Barton, recently General Superintendent of the New York & New England R. R., and formerly of the Long Island R. R., has been appointed General Superintendent of the Brooklyn Elevated R. R.

Mr. Charles M. Hays, General Superintendent of the Wabash R. R., has been elected Vice-President of the company, vice Col. James F. How, resigned. Mr. Hays will retain his position as General Superintendent.

Mr. T. A. Mackinnon, General Manager of the Concord & Montreal R. R., has been appointed General Manager of the Boston & Maine R. R., with headquarters at Boston, Mass., vice Mr. J. W. Sanborn, who has been Acting General Manager.

Mr. J. C. Irwin has been appointed Assistant Superintendent of Signals of the Mohawk Division of the New York Central & Hudson River R. R., with office at Albany, N. Y., in addition to his duties as Superintendent of the Hudson River Bridge Co. at Albany.

Mr. A. H. Lighthall has been appointed a member of the Commission for Park Ave. Improvement, New York city. This work includes the elevation of the tracks of the New York Central & Hudson River R. R. from the Harlem River to the Grand Central Station.

Mr. William T. Manning has been appointed Chief Engineer of the Baltimore & Ohio R. R. Mr. Thomas Fitzgerald, General Superintendent of main stem and branches and Philadelphia Division, with headquarters at Baltimore, Md. Mr. J. Van Smith, General Superintendent of the trans-Ohio Division, with headquarters at Chicago.

Mr. Gavin Campbell, formerly General Superintendent of the Wisconsin Central Ry., died at Stevens Point, Wis., Jan. 31. He was born in Glasgow, Scotland, in 1836, and entered railway service in 1859 in this country, being connected with the mechanical department of different roads until 1878, when he was made Division Superintendent of the Wisconsin Central Ry., and became General Superintendent in 1889, holding that position until the road went into the hands of receivers a few months ago. In 1891 he was also appointed General Superintendent of the Chicago & Northern Pacific R. R. and Chicago & Calumet Terminal R. R.

Mr. Arthur H. Howland, M. Am. Soc. C. E., senior member of the late firm of Howland & Ellis, of Boston, was reported to have committed suicide on Dec. 29 by jumping from the steamer "Pilgrim" while en route from Boston to New York. It now appears that Mr. Howland did not jump from the boat, but adopted an assumed name on arrival in New York, and has been keeping his identity secret. It has been stated that his object in causing the reports of suicide and concealing himself was to collect an insurance of $50,000 on his life; but it is also stated that under the terms of the policies which he held he could gain little or nothing by such a course. It appears to be not only charitable but sensible to conclude from all the reported circumstances of the case that Mr. Howland must have been mentally unbalanced at the time of his disappearance.

Mr. Samuel C. Slaymaker, City Engineer of Lancaster, Pa., died of apoplexy in that city on Feb. 2. Mr. Slaymaker was born in Lancaster County, Pa., April 22, 1828, and in 1852-53 was one of the assistants of the late John C. Trautwine in railway surveys in Central America. He was later Resident Engineer and for a short time Chief Engineer of the Philadelphia & Reading R. R., and Chief Engineer of the N. J. & West Line R. R., the Lancaster, Oxford & Southern R. R., the Phila., Newtown & New York and other lines. He was almost constantly employed in professional work and was especially known as a most experienced and methodical locating engineer for railways. He was for many years City Engineer for the city of Lancaster, Pa. Our last issue contained a portrait of Mr. Slaymaker.

Mr. James W. Tyrrell, who, with his brother, Lieut. Joseph B. Tyrrell, has lately returned from an exploration of a hitherto unknown region west of Hudson's Bay, is a civil engineer of Hamilton, Ont., and the engineer of the Hamilton & Barton inclined railway, described in Engineering News of April 13, 1893. These two gentlemen, familiar with the wilds of Canada as surveyors and geologists, were selected by the Ottawa Government to explore the Barren Lands lying immediately west of Hudson Bay, and before only known through confused Indian legends. They started out in May of 1893 with six Indians from the northern end of Lake Athabasca and going about 830 miles east of north, finally struck Chesterfield Inlet and

Hudson Bay; then came 500 miles south by canoe to Fort Churchill, the by way of York Factory, Oxford House, Norway House and Lake Winnipeg to Selkirk. The total mileage by canoe was 2,200; by snowshoe travel, 650, and by dog-sled, 350 miles. They proved by their adventurous journey that, but for what minerals may be found, the Barren Lands are of small value, totally unwooded and with no large game, and little game of any kind, and practically untraveled, even by the Indians and Esquimaux.

NEW PUBLICATIONS.

FEBRUARY MAGAZINES.—In "Harper's" we find the tenth in the series of articles on "Great American Industries," entitled "A Bar of Iron." The series is edited by Mr. R. R. Bowker, well known in electrical circles as the executive manager of the Edison Electric Illuminating Co., of New York city. The description of modern processes is of course of the elementary character suited to the general reader; but the historical portion is very well written and complete and contains information which will interest many engineers.

In "Scribner's" Mr. Joel Chandler Harris describes the devastation wrought by last summer's hurricanes on the Sea Islands of the South Carolina coast. In "The Century" Mr. T. C. Martin, editor of the "Electrical Engineer," has a brief article on Nikola Tesla. A paper which purports to describe the experiences of a tramp stealing rides from Albany to Buffalo and thence over various railways to New York, deserves reading by every railway manager who is studying how to cope with the tramp nuisance. In the "Review of Reviews" we find an interesting summary of the methods of raising revenue adopted by the principal nations of the world. A finely illustrated paper by Carl Snyder describes the scenery about Mt. Tacoma, Wash., where it is proposed to establish a new national park. Mr. Grant Allen gives a brief account of the life and work of the late John Tyndall, and the useful paper on the relief measures adopted in American cities is continued.

In "McClure's" for January Cy. Warman describes a ride on the cab of the locomotive drawing the Empire State Express, and among other things he repeats the old story that the way to make a quick stop in an emergency is first to apply the brakes and then reverse the engine. It behooves superintendents of motive power who have their engines equipped with driver brakes operated automatically with the train brakes to ascertain just what ideas are current among their engineers. The old idea that the thing to do in a tight place was to "pull her over and give her steam," which was correct enough before the days of driver brakes, has a tenacious hold, and the men should be thoroughly instructed as to the reason why it is no longer best to reverse the engine in an emergency.

In "The Forum" Courtenay De Kalb writes on "The Nicaragua Canal—Ours or England's?" and urges that the United States government should take hold of this enterprise before it falls into the hands of British capitalists. There are two papers on the currency question, one by Edward Atkinson, who claims that the gold basis is fixed by commerce itself, the other by J. E. Fraenkel, who argues that there is likely to be a steady increase in gold production for many years to come, through the development of processes for treating low grade ores and through the discovery of new fields in South Africa. Mr. Hamilton Smith, an American mining engineer familiar with the Transvaal, predicts that its output will reach $50,000,000 per annum in three or four years. "To Rob Consumption of Its Terrors" is the title of a paper which sums up the recent discoveries by the students of tuberculosis, and outlines the methods which should be adopted to stamp out the disease. It should be read by every one interested in sanitary science. In the "North American Review" Mr. John E. Leet writes on "Colorado's Bright Outlook," and declares that were it not for the unemployed men who have come from the East, there would not now be a man in the state unable to find work. "Friendly Receiverships" are discussed by another writer, who condemns the present practice of throwing a corporation into a receiver's hands on petition of its responsible officers. Our readers interested in social reform should not fail to read Governor Tillman's account of South Carolina's new and much maligned liquor law. It is the first intelligent description of the novel and very promising method of controlling the liquor traffic which South Carolina has adopted that we have thus far seen in print.

NEW ENGLAND ROADMASTERS' ASSOCIATION.—Proceedings of the Eleventh Annual Convention, held at Boston, Mass., Aug. 16 and 17, 1893. Secretary, E. E. Stone, B. & A. R. R., Springfield, Mass. 8vo; pp. 157.

The subjects discussed at this meeting were as follows: "Best Method of Relaying Rail in Main Track," "Spring Rail and Stiff Rail Frogs," "Care of Station Grounds," and "Gravel Pits, Ballast and Ballasting." The discussions are reported in full and contain much valuable and interesting information. In addition there is a valuable paper by Mr. P. H. Dudley on "The Manufacture of Steel Rails," an abstract of which was published in our issue of Aug. 31, 1893.

ELECTRIC WAVES.—Being Researches on the Propagation of Electric Action with Finite Velocity through Space, by the late Dr. Heinrich Hertz, Professor of Physics in the University of Bonn. Authorized English Translation by D. E. Jones, B. Sc., with preface by Lord Kelvin, London and New York: Macmillan & Co.; 8vo; cloth; pp. 278, with 40 illustrations; $2.50.

The work accomplished by the brilliant young German scientist, whose untimely death occurred last month, is briefly summed up by Lord Kelvin in his preface to the volume before us as follows:

For electricity and magnetism Faraday's anticipations and Clerk-Maxwell's splendidly developed theory (of the propagation of electrical and magnetic action through a medium) have been established on the sure basis of experiment by Hertz's work, of which his own most interesting account is now presented to the English reader.

A large part of the volume before us appeals of necessity only to those well versed in modern electrical and physical science; portions of it, however, are not too abstruse for the general reader of scientific tastes. The work done by Professor Hertz in establishing on a firm basis the ether wave theory of electrical and magnetic action may have practical results as yet undreamed of in the new era of electrical development on which we are entering.

TRADE PUBLICATIONS.

GAS, STEAM AND WATER FITTINGS.—Jarecki Mfg. Co., Erie, Pa. 8vo; pp. 300.

This is an illustrated catalogue and price list of malleable and cast iron fittings for gas, steam and water pipe; cocks and valves, radiators, pipe threading machines and general supplies for oil, water and gas wells. The index covers 14 pp.

SOCIETY PROCEEDINGS.

PENNSYLVANIA STATE SANITARY CONVENTION.—The remarks on water purification and typhoid fever, mentioned under the above heading in our issue of Feb. 1, were made by Mr. Jas. H. Harlow, instead of Mr. Jas. H. Harlan, as there stated.

ENGINEERS' CLUB OF CINCINNATI.—At the last annual meeting of the club Col. Latham Anderson presented selections from a translation of an article by M. Comoy, Inspector-General of Bridges and Roads, retired, in the Annales des Ponts et Chaussees on "Various Methods for the Consolidation of Earth Slides." (This paper was translated for Engineering News by the late Col. W. E. Merrill, U. S. A., and published in our issues of Sept. 22 and 29, and Oct. 6 and 13, 1877.—Ed.)

J. F. Wilson, Secy.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The second annual meeting of the Chemical Section was held Jan. 23 and officers were elected as follows: Chairman, Walter E. Koch; Vice-Chairman, James M. Camp; Secretary, Abram T. Eastwick. The regular meeting was called to order after the adjournment of the annual meeting, and a paper on "The Well, Spring and River Waters of McKeesport and Vicinity," by R. B. Carnahan and Fred Crabtree, was read by Mr. Carnahan.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The next meeting will take place at the Kimball House, Atlanta, Ga., April 19. The subjects for discussion will be as follows: 1, "Construction of Ends of Box Cars; the Cause of and Remedy for the Bulging Out of Ends of Box Cars"; 2, "Is the Collar or Collarless Axle the Best Adapted to General Rolling Stock Service?" 3, "The Relative Strength of Different Patterns of Metallic and Composite and Wooden Brake-beams under Service Strains." Reports are expected on "The Most Improved Methods for Rapidly Cleaning Soot and Cinders from Inside of Locomotive Boiler Tubes While Engines are in Engine Houses" and on "Soft Plugs for Crown Sheets of Fireboxes, Best Form, and How to Keep Them Effective." The club will take action and make recommendations to the Arbitration Committee of the M. C. B. Association from the report of the committee appointed to see "What Part of the Present Code of M. C. B. Rules It Might be Advisable to Alter in Order to Better Meet the Requirements of Interchange."

S. A. Charpiot, Secy.

INDIANA ENGINEERING SOCIETY.—The 14th annual convention was held in the State House at Indianapolis, Ind., Jan. 2, 3 and 4. The following papers were read and discussed: "The Location, Design and Construction of Open Drains," L. A. Bostwick; "The Allotment of Drains for Repairs," J. E. Alter; "Bad Descriptions in Deeds," Jno. W. Fawcett; "How to Utilize the Waters of the Kankakee," Prof. John L. Campbell; "Some Experiences of the City Engineer in a Small City," C. G. H. Goss; "The Proposition for a State Engineer," Wallace Marshall; "Recent Road Legislation," J. F. O'Brien; "The Separate System of Sewers for the Smaller Cities," Charles C. Brown; "The Construction of Sewers," Charles L. Kinney; "The Good Roads Question," William Fortune. The annual report of the secretary-treasurer showed the society to be in a good condition financially. The following officers were elected: President, C. G. H. Goss, Martinsville, Ind.; Secretary-Treasurer, J. R. Brown, Frankfort, Ind.

BOSTON SOCIETY OF CIVIL ENGINEERS.—At the regular meeting on Jan. 24 the discussion of the evening was in continuation of that of the last meeting, namely: "The Organization of a City Engineer's Office and the Best Methods of Carrying on Its Work." Mr. A. F. Noyes read abstracts from the paper presented by him at the last meeting on the organization of the office, and he was followed on the same subject by Mr. L. M. Hastings and Mr. W. E. McClintock. A description of the organization of the city engineer's office at Providence, R. I., by Mr. O. F. Clapp was read by the secretary. Mr. G. A. Kimball read a paper on "The Management of a City Engineer's Office," and Mr. John C. Olmstead read one on "The Relations of the City Engineer to the Landscape Architect and to Public Parks." Mr. W. E. McClintock read the last paper of the evening on "City Surveys and Maps," and Mr. Fred Brooks spoke of rectangular co-ordinates and uniformity of datum plane of levels in their relation to municipal surveys. A special meeting was held Feb. 6 to continue the discussion on the work of a city engineer's office.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF KANSAS CITY.
Feb. 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Feb. 12. Secy., M. F. Schinke, City Hall, Milwaukee.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 12, 18. Virginia Beach, Va. Secy., R. W. Raymond, 13 Burling Slip, New York.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 13. Secy., F. C. Osborn, Case Library Building.
NORTHWEST RAILROAD CLUB.
Feb. 13. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF CIVIL ENGINEERS.
Feb. 13. Secy., F. E. King, Jacobson Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Feb. 14. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Feb. 14. "Lubrication of Journals on Rolling Stock." Secy., F. M. Curtis, P. O. Box 1576, Boston.
AMERICAN SOC. OF MECHANICAL ENGINEERS.
Feb. 14. Secy., F. R. Hutton, 12 W. 31st St., New York.
ENGINEERS' CLUB OF CINCINNATI.
Feb. 15. J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
Feb. 15. Secy., John A. Hill, Temple Court.
SCANDINAVIAN ENGINEERING SOC. OF CHICAGO.
Feb. 15. Secy., Howard Berge, 100 Washington St.
TACOMA SOC. OF ENGINEERS AND ARCHITECTS.
Feb. 16. 201 Washington Building.
NORTHWESTERN TRACK AND BRIDGE ASSO'N.
Feb. 16. Secy., D. W. Meeker, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
Feb. 17. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
Feb. 17. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 19. Secy., E. Nexsen, 504 Kasota Block.
ENGINEERS' SOC. OF WESTERN PENNSYLVANIA.
Feb. 20. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Feb. 20. Secy., Clement F. Street, Rookery, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
Feb. 20. Secy., F. W. Hart, Washington, D. C.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Feb. 21. Secy., S. E. Tinkham, 36 Bromfield St.
ENGINEERS' CLUB OF ST. LOUIS.
Feb. 21. Secy., Wm. H. Bryan, Turner Bldg.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Feb 21. Secy., F. Collingwood, 127 E. 23d St., New York.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Feb. 21. Secy., L. J. Carmait, Roanoke, Va.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
March 2. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
March 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
March 5. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
March 6. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
March 7. Secy., J. W. Weston, Lakeside Bldg., Chicago.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
March 8. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERING ASSOCIATION OF THE SOUTH.
March 8. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS' AND ARCHITS CLUB OF LOUISVILLE.
March 8. Secy., F. W. Mowbray, Norton Building.
MONTANA SOCIETY OF CIVIL ENGINEERS.
March 10. Secy., G. O. Foss, Helena.
CENTRAL RAILWAY CLUB.
March 28. Secy., S. W. Spear, Buffalo, N. Y.
AMERICAN RAILWAY ASSOCIATION.
April 11. Secy., W. F. Allen, 24 Park Place, New York.
SOUTHERN & SOUTHWESTERN RAILWAY CLUB.
April 19. Secy., S. A. Charpiot, Macon, Ga.
MASTER CAR BUILDERS' ASSOCIATION.
June 12, 16. Saratoga, N. Y. Secy., J. W. Cloud, Rookery Building, Chicago.
MASTER MECHANICS' ASSOCIATION.
June 19, 23. Saratoga, N. Y. Secy., Angus Sinclair, Temple Court, New York.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York, as Second Class Matter.

VOL. XXXI. THURSDAY FEB. 8, 1894.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, } ASSOCIATE EDITORS
M. N. BAKER, CHARLES S. HILL, }
GEO. H. FROST.....BUSINESS MANAGER
F. P. BURT.....ASSISTANT MANAGER

CHICAGO OFFICE: Monadnock Building, corner Dearborn and Van Buren Sts.
F. A. PECKHAM.....MANAGER

EUROPEAN AGENCIES:
KEGAN PAUL, TRENCH, TRUEBNER & Co. (Limited), Paternoster House, Charing Cross Road, London, Eng.
SAMPSON LOW, MARSTON & Co. (Limited), St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: United States, Canada and Mexico. One Year, $5.00; 6 months, $2.50; 2 months, $1.00; single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The date when the subscription expires is on the address label on each paper; the change of this to a subsequent date is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

Numerous reports have been in circulation of late concerning a proposed electric railway to extend from Philadelphia to New York city. While published statements in the newspapers are somewhat conflicting, it appears certain that the promoters of the scheme do not contemplate, except incidentally, the carriage of through passengers between the two cities. The line will be built for the most part along roads and streets and will be limited to usual rates of speed. The traffic which it is expected to secure is the local traffic along the line, which is projected to run from Jersey City via Newark, to Elizabeth, and thence following the general course of the Central Railroad of New Jersey, through El Mora, Roselle, Cranford, Garwood, Westfield, Graceland, Fanwood, Netherwood and Plainfield. From this point it is proposed to turn south to New Brunswick and then follow westward about midway between the Pennsylvania R. R. and the Philadelphia & Reading's Bound Brook line to Trenton. From Trenton to Philadelphia the line would closely parallel the Pennsylvania. According to other reports it is the intention of the projectors to penetrate the thickly settled suburban towns of Morris and Essex counties, instead of paralleling the Central Railroad of New Jersey route; this would increase still further the total length of the line.

The reports concerning this projected electric railway intended for local communication merely, have been magnified in some cases to include a real high-speed electric railway between the two cities; but we do not understand that the promoters of the present enterprise contemplate such a thing. Doubtless they are wise in sticking to the sure profits of local travel, but the occasion seems opportune to call attention to the interest which a scheme for a real electric high-speed railway between New York city and Philadelphia would possess, both from an engineering and a financial standpoint. Recent experience on steam railways has proved that a speed of 100 miles an hour is possible, on a first-class track; and provided a clear track can be assured, it is yet to be shown that such a speed on a road built for it is unsafe. That an electric locomotive to attain this speed could be constructed, will scarcely be questioned by those who are familiar with current progress in electricity. The engineering features of the enterprise, then, would present no grave difficulties, so far as can be seen; and from a financial point of view, it may simply be said that if a high-speed "interurban" electric line can be made profitable anywhere in the world, it is between New York and Philadelphia. These two cities, with their suburbs and adjacent towns, constitute the two largest centers of population in the country. The distance between them is short enough to bring the cost of such a road somewhere within reasonable limits, and at the same time it is great enough to make the time saved due to a running speed of say 100 miles per hour, a very sensible gain over the ordinary speeds of 30 to 60 miles per hour. The amount of travel between the two cities is already very large and would doubtless be materially increased if the two cities were brought within an even hour of each other, with through express trains leaving from each end at half-hour intervals. The rolling stock required for such a high-speed service is curiously small, only four trains in all, if we assume that a train can start back on its journey as soon as it can discharge and receive its passengers. Moreover if the line were intended for express service only, a single track with three passing points would serve for half-hourly trains. The great difficulty which such an enterprise would have to surmount would be the securing of an entrance to the cities at each end, a task which would be doubtless a most expensive one, and on which the success of the whole scheme would hang.

That the experiment of a high-speed electric railway is pretty certain to be tried before many years will probably be generally admitted. It is to be hoped that when it is undertaken a location may be chosen where financial as well as engineering success can be hoped for, and where the necessary investment will not be so great as to cause failure in the electrical features through an attempt to economize in first cost. Thus the state of suspended animation, temporary or permanent, which at present afflicts the much-heralded Chicago & St. Louis electric railway is really cause for congratulation to those who believe in the feasibility of high-speed electric railways; and it is hoped that its trance may continue, at least until a road on similar lines is built in some more promising location.

The completion of the Manchester ship canal has awakened interest in deep water connections with the sea in Europe generally, and a number of more or less ancient projects are being regalvanized into life. Chief among these in importance is the deepening of the Seine from Havre to Paris. This plan has been long discussed and elaborately worked up from an engineering point of view, but is making little material progress. France is also again discussing the still greater project of cutting a ship canal across the south of France, from Bordeaux to Narbonne, connecting the Bay of Biscay with the Mediterranean Sea, and a bill for the construction of this canal was introduced into the French Chamber last year. The proposed canal would be about 325 miles long, from 120 to 230 ft. wide on the surface and 27 ft. deep. Large premiums in cash are offered by the projectors for the best detailed plans and several years may yet elapse before the preliminaries are arranged. But France seems to be deeply impressed with the desirability of thus providing a ship canal that would not only be commercially useful in reducing distances between points on its own coast, but would be also of immense strategic value in passing her fleet from the Mediterranean to the Atlantic Coast. Brussels, also, wishes to enlarge and deepen the channel which now connects it with the North Sea, and thus provide a passage for ocean-going vessels of at least the second class in tonnage. It is estimated that an expenditure of about $10,000,000 would give a uniform depth of 22 ft., admitting vessels of 2,000 tons, and the Belgian government has offered to take a considerable part of the stock of the canal company and has already made a subsidy appropriation for it. Bruges also seeks to regain some of its old-time commercial prosperity by cutting a canal to the sea; and somewhat vigorous attempts are now being made to induce capital to look kindly upon the scheme. The Corinth Canal was opened to traffic last August, and Greece expects much needed financial profit from the use of this new waterway by the commerce of the neighboring seas.

Italy is also proposing ship canals through her territory, but lacks funds and the credit necessary for any early consummation of her desires. One project at an estimated cost of $125,000,000, provides for a canal from the west coast, near Rome, 125 miles northeast to Fano, on the Adriatic. A width of 270 ft. and a depth of not less than 40 ft. is proposed, so that the heaviest warships may pass through. The other Italian project seems much more useful and is a 24-mile canal across the province of Catanzaro, cutting across the toe of the geographical "boot." This channel would obviate the necessity of going around Sicily, or of passing through the dangerous Straits of Messina. The North Sea and Baltic ship canal, upon which over $30,000,000 has already been expended, is nearing completion, and its opening for traffic is promised for 1895. Smaller projects swarm in Europe, but exist as projects only; and the same remark would practically apply to the host of schemes for building ship canals in the United States and Canada, now before the public. With the exception of the Chicago drainage canal and the Hennepin canal, which are not ship canals at all in the sense here used, the American canals are projects, or have only a corporate existence. The most lively home interest is now shown in the proposed Cape Cod ship canal; but the trouble seems to be that too many companies are seeking rights when there is at best profit for only one canal, and the present conflict may again strangle the life out of this long discussed and several times started enterprise. A return of prosperous times may see some of these schemes materalized; and first among works of this character on the American continent will probably be a Nicaragua ship canal, the most important project of this kind now before the commercial world and a canal for which the world cannot much longer wait.

THE LAST RAPID TRANSIT PROPOSITION FOR NEW YORK.

After three years of existence; after an alleged earnest attempt to sell the franchise for tunnel construction; after dallying with the Manhattan system and toying with another elevated proposal which would have practically been little more than a feeder to a new East River bridge, the New York Rapid Transit Commission has at last recommended a plan which has in it some elements of feasible and reasonably early construction. This plan includes a tunnel on the route first laid down by the commission, and would thus provide what is without doubt the most substantial roadbed for rapidly moving trains on the line of greatest travel in New York. A tunnel has its disadvantages; but these can be minimized by electric light, electric elevators and electric means of propulsion and ventilation; and, as compared with any feasible type of elevated structure upon the lines best adapted for rapid transit in New York, a tunnel is in every way to be preferred. From an engineering point of view the project includes no insurmountable problems of construction, and only requires sufficient cash or credit and competent engineering supervision to insure its material success. But there are some other features in the proposition as it now stands that require a little consideration.

The commission attempted to have this same tunnel built by private capital two years ago, and the reasons for their failure to secure bona fide bids were then fully pointed out and discussed by this journal. The conditions of absolute control by the commission during construction, wordy, but ill-defined specifications, and the acceptance of all risks, those political as well as those arising from natural causes, were very uninviting to an honest investment of capital. These same reasons for refusal are even more potent in these hard times than they were two years ago. Were it possible to have the project intelligently and honestly handled for the best interests of the city alone, the most satisfactory plan of all would doubtless be to have the whole proposed rapid transit plant built and owned by the city, and leased out for operation on terms just and profitable to the oper-

ators, but also fair to the city. This plan should provide a roadbed at a minimum cost and in operation yield a very handsome and growing profit to the city treasury. Unfortunately, the millennium is not quite at hand and for a road actually built upon this theory, the first cost and final profits of operation would be both unknown quantities.

Now comes a proposition from a private corporation practically asking the city to loan its credit for two-thirds of the estimated cost of construction with a promise of private capital for the rest. As any sufficient and well constructed system of rapid transit must be viewed in the light of a great public improvement, this proposition would seem fair enough, were the city to retain two-thirds of the control and benefit to that extent in the future profits. But this does not seem to be the purpose of Mr. Wilson and his friends, who promise to pay back principal and interest of this loan in a given term of years, upon condition that the private corporation shall thenceforward own the road. Opposed to this proposition is the Constitution of the State of New York, which very properly forbids the loan of the public credit to a private enterprise, as this would be in fact, and before anything could be done by those interested, special legislative enactment would be necessary. The commission recommends this action and also a popular vote upon the question.

While this is one way of obtaining rapid transit, and the commission practically claims that it is the only way, it is far from being business-like or proper, upon its face. As we read the conditions, the city would be simply loaning its credit for a term of years, and for this time be secured by a first mortgage on the road and by the investment of $15,000,000 of private capital. This is doubtless excellent security; but the precedent established is bad, against existing law, and the people of New York obtain too little, or practically nothing, for the use of their good name and financial standing, if, when the loan is paid, they are to relinquish all interest and ownership in an enterprise which the present commission claims can only be brought into existence by their active assistance as a municipality.

With all due respect to the Rapid Transit Commission we do not believe that this necessity for the loan of the city's credit actually exists; for we do not believe that this commission has exhausted all the methods possible for inviting private capital to enter into this enterprise. Let it try a new experiment, if the powers that be will permit, and invite proposals on a broader and more liberal basis; make the transaction, in fact, sufficiently businesslike to invite business capital. No corporation is going into this affair unless it sees a goodly profit, in the first place; and in the second place is assured against political meddling and bleeding during the actual construction of the work. Before any responsible corporation or syndicate can be expected to seriously consider the subject of rapid transit construction it must have its responsibilities, obligations and rights much more clearly defined in advance than has yet been done.

The project is a most interesting one from an engineering standpoint and one of very large financial proportions, with practically unlimited capabilities for profit if the enterprise is honestly handled. Under these conditions it is not at all necessary that it be made a purely local enterprise, under the impression that all profits from construction and operation should remain in the hands of New York capitalists, constructors and engineers. The prime and only good reason for construction at all is the providing of rapid transit for the people of this city as ample, cheap and speedily as capital and human intelligence combined can provide it, no matter where these essential factors come from. So far, no foreign money or talent has been invited to aid in the solution of this problem; nor could it be expected to come, even if invited, under the conditions hitherto imposed.

Even the question of route, downtown at least, seems to have been too lightly considered. Broadway, narrow and lined with lofty and costly building, crowded with traffic and underlaid with a network of pipes, conduits and underground street fixtures of unknown quantity and location, has practically been assumed as the only feasible route for tunnel construction. Yet, within one or two blocks to the east of this busy thoroughfare lies Elm St., quite as well situated for a trunk line of travel; practically parallel to the parts of Broadway likely to be most troublesome and expensive in construction, and yet so entirely different in the class of houses lining this street and material under the street as to render construction easier and cheaper because less risky. This Elm St. is now in process of construction, widening and straightening, and it would be at least a business-like proposition to carefully consider the comparative cost of widening the street still further, while the city was at it, and building a depressed four-track road in the center, with bridges at the streets from, say, City Hall to Union Square. The money thus saved in providing a roadbed, as compared with the cost of tunneling under Broadway, might go far toward paying for the additional property required. But assuming that the tunnel plan is best for the whole route, the Elm St. route seems to be in every way preferable, for it would eliminate from the problem that very important mile and a half of Broadway lying between the City Hall and Union Square. In estimating upon the probable cost of a piece of constructive work of this character, the risks to be assumed and the chances for accident enter very largely into the figure of aggregate cost, and the more these chances and risks are reduced the closer will be the builder's estimate and bid.

In the three years' work of the Rapid Transit Commission the methods for not providing rapid transit have been very fairly discussed. It is now suggested that the radically different plan be tried of earnestly and intelligently working for the nominal end in view. Pay premiums sufficiently large to invite the engineering talent of the world to present plans and estimates; appoint a board of the ablest, most experienced and thoroughly independent engineers to fix upon the most desirable route and plans for construction; make as complete detailed plans to submit to bidders as did the New Croton Aqueduct Board, and draw up conditions of letting and define the rights and responsibilities of the builders as clearly and carefully as if it were private and not city work that was to be done; and, finally, let the construction alone, or let it with the added privilege of operation for not more than 50 years, with an absolute reversion to the city at the end of that term. This is a mere outline of a plan, but it is a plan that has not been fairly tried as yet; and if local interest and political influence render its realization impossible, then let the people wait for rapid transit until the times change.

SPEED PREMIUMS IN NAVAL CONTRACTS.

A good deal of criticism has been heard in the newspapers lately concerning the policy pursued by the Navy Department in offering premiums to the contractors for naval vessels for securing an excess of speed over the contract requirements on the trial trip. The bulk of this criticism is about as follows: During the building of the new navy the government has paid in round numbers about 1½ million dollars in speed premiums. This is a large sum, say the critics, to go into the pockets of the naval contractors, and, moreover, the speed that is obtained is only a forced spurt and could not be repeated in the vessel's actual service. To present the arraignment of the navy department more in detail, we quote the following from a recent editorial in the New York "Tribune":

> The contract price of the "Montgomery" as a 17-knot ship was about $600,000. It is constructed as a 19-knot ship and costs about $800,000. One of two inferences is to be drawn: Either that the designs and specifications made this increase of 2 knots practicable, or else that the contractors have sacrificed everything to speed. In one case the work of the department experts is to be condemned as unscientific, and in the other dangerous tendencies of naval construction are developed. It is preposterous to assume that the government, after twelve years of construction for the new navy, during which the genius and efficiency of American designers and shipbuilders have been triumphantly vindicated, cannot contract directly, for a ship of 19, 20 or 21 knots, and get precisely what it asks for. It is wholly unnecessary and well nigh scandalous, to invite proposals for a 17-knot ship and then to pay $200,000, in addition to the contract price, for the artificial record of a 19-knot ship. We say "the artificial record," for it must not be forgotten that the trials occur under conditions which will never be reproduced, and that the machinery is subjected to a tremendous strain for the sake of forcing a speed which can never be made again in actual sea service. That record is not worth what it costs. The system is unbusinesslike, wasteful and radically wrong.

These are serious charges, and it is worth while to look into the matter in some detail. First, as to the matter of the speed trials, no one save a "landlubber" with no knowledge of engineering, supposes that the speed of a vessel on her contract trial is the speed which the vessel can keep up to on a long run, or that she can ever repeat the performance if her machinery is not in the best condition or her bottom is foul. But the speed obtained on the contract trial is an index, and a most valuable one, of the actual service speed which the vessel can be relied on to make. This is especially true where the contract trial is made over a long course or the vessel is subjected to a four-hour run at full power. The contractor is supposed to turn the vessel over in perfect condition. He has a right, then, to have her speed tested in that condition and under the most efficient management, just as much as an engine builder has a right to have the duty trial of his machine made with it in perfect order and with a competent engineer in charge. Viewed in this light it appears plain that the speed trial does indicate what lower speed the ship can make under ordinary conditions as well as record her maximum speed under the selected conditions of the contract trial.

We may now fairly take up the question whether the policy of making the speed requirement considerably less than the speed that a first-class builder can secure in conforming to the plans and specifications is a wise one, and this practice is really the main thing which the would-be economists are attacking. "If the plans and specifications which the Navy Department draws up may be expected to produce a 19-knot ship, why not call for a speed of 19 knots on the contract trial," says the newspaper or Congressional critic. Suppose the advice of these critics were followed and bids for new vessels were called for on this basis, the vessels to be rejected if the maximum speed is not attained. The shipbuilder of small capital examines the plans and says: "I think I could build the vessel to make that speed, but I can't be absolutely certain of it, and it would bankrupt me to have the vessel rejected; I'll not bid." Other shipbuilders are still less certain of their ability to meet the contract requirements and so it would come about that the competition would be restricted to the two or three firms who had had sufficient experience in building government vessels to know of a certainty what speeds they could secure, and who had capital enough to sustain them in the event of the vessel's rejection.

Should the Navy Department establish such a method of letting vessel contracts, it might and probably would be accused of discrimination in favor of the few great shipbuilders and against the smaller firms. Whatever may be said for or against the practice of making specifications so strict as to shut out all save a few bidders, it is a familiar fact that it almost invariably gives rise to charges of corruption.

But it may be said that instead of rejecting the vessel if it falls below contract requirements, the Navy might accept her at a lower figure, according to the deficiency in speed which was shown. This would be merely substituting a system of fines for a system of premiums; and while from one point of view the two systems are equivalent, it will probably be generally agreed that as a practical matter the system of premiums is greatly to be preferred.

That the speed requirement is a beneficial addition to the contract will hardly be questioned. It puts the contractor on his mettle to put in such good material, good workmanship and good design, so far as the last named is within his control, that the vessel will be equal to a first class performance. The strictest specifications and the strictest inspection cannot accomplish everything. The incentive to good work which a handsome premium offers is of direct value to the government, and from this point of view the million and a half in speed premiums which it has paid was money well invested.

Remembering that all contracts for building new vessels are let to the lowest bidder and that every bidder takes into consideration his chances of securing a speed premium when fixing his price, it must be seen that instead of the premium system be-

ing a "scandalous" method of letting contracts, as the "Tribune" alleges, it is really an admirable system, well designed to secure the best results to the government at the smallest cost. So far from deserving criticism, it deserves to be brought to the general attention of engineers, for it invites the largest competition by setting the fixed requirements at a point which the smaller contractors can feel sure of reaching, and secures the best workmanship and best results by making it for the contractor's direct interest to build a vessel that will beat the record.

LETTERS TO THE EDITOR.

RECORDING THE VIBRATIONS OF BRIDGES.

Sir: It is to be regretted that Mr. Noonan, in his reference in Engineering News of Nov. 9, 1893, to his device originated "several years ago," did not fix the date of origination.

As to early work in the recording of bridge deflections and vibrations, I am informed that in the second edition of Navier's "Resistance of Materials" the following occurs: "Two experiments were made by passing locomotives over the bridges, and the deflections at different points were observed by means of pencils marking their traces on a plane table supported on both sides by the abutments." The date of Navier's work referred to I am not able to give, but it must be "several years" old.

I am informed that Mr. J. T. Fanning, M. Am. Soc. C. E., in 1875 obtained diagrams by aid of a station near mid-span, to which and to the bridge a pencil and a card were so attached that the motions of the bridge were marked on the card.

In August, 1881, I made experiments by fastening a paper covered board to a bridge at mid-span, at right angles to the length of bridge and erecting a staging from the ground below, leaving a pencil so that the motions of the bridge, as trains passed, were marked down on the paper. This device gave record of lateral, as well as vertical movements in a somewhat confused mass, from which, however, the maximum vertical and horizontal movements could be measured. Some of these diagrams were published in "Railroad Economics," Van Nostrand's Science Series, No. 59.

Later I had a bridge indicator made and applied to several bridges, by which the paper was moved along by clockwork, while the pencil was under motion by the bridge as trains passed. A developed record of the deflections and vibrations of the bridge was thus obtained which proved to be full of interest as touching on the points of bridge vibration due to the non-balance of locomotive drivers, and the relation of panel length of bridge and length of freight cars. Results were published in Trans. Am. Soc. C. E., Vol. XVI., February, 1887, though presented to the society on June 26, 1887.

I hope to hear from others on the subject of recording, automatically, the motion of bridges.

Yours truly,
S. W. Robinson, M. Am. Soc. C. E.
Ohio State University, Columbus, O., Jan. 15, 1894.

EARLY STEEL BRIDGES IN AMERICA.

Sir: To the table of early steel bridges in America, given in your issue of Dec. 28, 1893, should be added the name of the Smithfield St. bridge, in Pittsburg, Pa., built in 1881-2. It had at the time the heaviest steel eye-bars made in the country, namely, 7 × 1⅞ ins., made by the Kloman process. In this process the shank of the eye-bar was rolled out between reversible rolls, leaving both ends thick, which were then hammered out under a steam hammer to the form and size of the eye. No dies were used in shaping the eye, merely a template. The eye-bars were not annealed, as tests made for the purpose showed that in this case it was not necessary. I may add that the work at the smith shop was in charge of a most excellent and exceptionally intelligent hammer man. I would not accept now unannealed steel eye-bars. The Kloman process has gone out of use.

Great trouble was experienced at that time in obtaining steel plates 20 ins. × 1 in. and 28 ft. long; in fact, they could not be obtained at all in this country, and the chord sections had to be composed of narrow plates, from ⅝ to ⅝ in. thick and 10 ins. to 12 ins. wide. The punched holes were not reamed. The tests showed that it was not necessary with that thickness of plates, which was less than the diameter of the rivets. A small quantity of the steel was furnished by the Homestead Steel Works, before Carnegie owned them, but the larger amount of steel was furnished by Schoenberger & Co., and Spang, Chalfant & Co., of Pittsburg.

Gustav Lindenthal, M. Am. Soc. C. E.
Pittsburg, Pa., Jan. 2, 1894.

Sir: There should be added to the list of early steel bridges, printed in your issue of Dec. 28, the bridge over the Missouri River at Glasgow, Mo., and also the double-track drawbridge over the Chicago River, on the line of the Chicago & Northwestern Ry., near the passenger station of this railway. Both these structures were built in 1878 by the American Bridge Works, of Chicago, and antedate any mentioned in your list, except the St. Louis Bridge. Steel for both structures, if I remember aright, was manufactured by Hussey, Howe & Co., of Pittsburg, and was made by what was then known as the "Hay Mat" process.

Yours truly, Chas. F. Loweth.
St. Paul, Minn., Jan. 6, 1894.

Sir: My attention has been called to the communication in Engineering News of Dec. 28, 1893, containing a list of early steel bridges built in the United States. No mention is made of the Glasgow Bridge, which was, so far as I can learn, the first large all-steel bridge erected in any country. This bridge carries the Chicago & Alton R. R. over the Missouri River, and was designed by me in 1878. Work on the substructure was begun May 8, 1878, and on April 20, 1879, the superstructure, including approaches, was completed. The entire work was under my personal supervision. All the metal in the bridge, even the name plate, is steel. I had thoroughly tested the mild steel which I proposed to use, and had found it 50% stronger than wrought iron, far more uniform in quality and nowise unsafe at low temperatures. Nearly all the prominent bridge engineers at that time strongly disapproved of the use of steel in railway structures. The steel used was made at the Edgar Thompson Works, the Bessemer process, as modified by Hay, being employed. A great number of tests of this steel were made. The elastic limit varied from 48,000 lbs. to 52,000 lbs. per sq. in., and the ultimate strength from 80,000 lbs. to 100,000 lbs. per sq. in. The parts of the structure were so proportioned that the maximum strain per square inch should be 16,000 lbs. Parts of several bridges built before the Glasgow Bridge are of steel; but as the latter was the pioneer all-steel bridge, and the first one in which mild steel, since generally employed, was used exclusively, it seems proper that it should have the prominent place it deserves in the record of steel bridge building. This record would be of value in settling any international contention as to the construction of the first steel bridge.

Yours very truly, Wm. Sooy Smith.
Chicago, Ill., Jan. 9, 1894.

(The Transactions of the American Institute of Mining Engineers, Vol. VIII., p. 19, state that: "The steel for the Glasgow Bridge over the Missouri River, the first all-steel bridge in this country, was manufactured under the 'Hay' process by the Edgar Thomson Steel Co., Ltd., and rolled by Hussey, Howe & Co., and Andrew Kloman into the various shapes used in constructing that bridge."

The following is the list of early steel bridges published in our issue of Dec. 28, 1893, revised to include the structures noted in the above letters. —Ed.)

Date.	Name.	Steel made by—
1869	St. Louis	Butcher.
1878	Glasgow	Hussey, Howe & Co.
1878	Chicago River	" " "
1879-83.	East River	Cambria Iron Co.
1880	Plattsmouth	....
1881-82.	Bismarck	Spang Steel & Iron Co.
1881-82.	Smithfield St., Pittsburg, Pa.	Homestead Steel Works; Schoenberger & Co.; Spang, Chalfant & Co.
1883	Blair	Cambria Iron Co.
1883	Willamette	Spang Steel & Iron Co.
1883	Niagara Cantilever.	" " " "
1883	Point Pleasant	Spang Steel & Iron Co.; Cambria Iron Co.
1884	Henderson	" " "
1884	Port Deposit	Carnegie Bros.

OF INTEREST TO BRIDGE ENGINEERS.

Sir: Within the past two years I have devoted a large amount of thought and labor to the subject of reducing the present incongruous system (or lack of system) in rolling loads and unit strains for railroad bridges to some more rational solution. I am now willing to vouch for having a solution that will be satisfactory to the most fastidious bridge engineer and give results agreeing with present methods with less than one-half the labor and complications, and to vouch for its adoption within 18 months after introduction by 60% of the mileage of those railways in the United States having 400 miles or more of main line. I am prepared to make this assertion after a complete canvass in a general way of the railways in question. Under the present system of bridge building the bulk of the saving would accrue to the bridge companies, as each company probably figures ten bridges where it builds one. Hence, as the whole scheme is only to save labor and not to improve upon the existing structures, the bridge engineer of the railway company could not be expected to be more than passively interested, and must be catered to and not called upon to do more than be agreeable.

It is my desire and wish to contribute this information to the engineering profession without profit to me, yet I am somewhat adverse to surrendering it at an actual loss, as the item of my personal labor would amount to about $3,000 based upon rate of actual salary while the work was in hand. Through your columns I would like to ask for suggestions from the general engineering public as to the best method of procedure. I find I have an elephant upon my hands which strongly resembles the one portrayed in "Wang." The question is, Should his elephantine majesty be consigned to browse on car couplers and rail splices without further considerate treatment?

Should he be consigned to the happy hunting ground and tagged an "Impossibility While the Bridge Engineer Exists"; or should he be turned loose upon the innocent public until a more rational method for doing his work is discovered and he becomes useless?

More seriously, the work is an extended tabulation of shears and moments of over 2,000 truss bridges which have been figured especially for this work, it differs entirely from all previous attempts to secure harmony and uniformity in this class of work, is extremely elastic in its application and it is thought the work will be found attractive, compact and accurate.

Yours truly,
R. H. Hood, Late Prof. C. E. Union, Mo.
Washington, D. C., Jan 27, 1894

CONCERNING MAGNETIC VARIATION.

Sir: There are so few data available, prior to 1810, of the variation of the declination of the magnetic needle, that I offer the following found by myself in locating the "Phillips Patent," in Dutchess, now Putnam County, N. Y.

The ancient "Fieldbook" reads as follows: "Thence run by the line of Lott No. 5, N. 9° 00' E. (1771), formerly N. 10° 0' E. (1753)." This would make a difference of 0° 51' in 18 years, showing an annual motion east in three years of 2' 51".

Yours truly, B. H. Brevoort.
Poughkeepsie, N. Y., Jan. 22.

(The U. S. Coast Survey has gone into the most elaborate study of this magnetic variation, and to these investigations surveyors should refer. The note furnished above is curious and interesting; but its accuracy and usefulness depend too much upon the "personal factor" in the surveyors of 1753 and 1771, and upon the relative merits of the instruments then used.—Ed.)

"A CONUNDRUM IN TRANSIT WORK."

Sir: In your issue of Jan. 4 your statement as to "A Conundrum in Transit Work" is, of course, correct; but your "briefly explained" seems to me defective in several points. You say: "The plumb line on a perfect transit, when set up, points to the center of the earth." Is it not the case that on account of the fact that the earth is not a sphere, but an oblate spheroid, there are only three positions on the whole earth where the plumb line points to the centre of the earth, those being at the North Pole, the South Pole and on the Equator? If so, it follows that nowhere away from the Equator and poles does "the plane in which the transit revolves" pass through the center of the earth, except when the transit points due north or south. Hence the other transit is in the same fix, and the two planes do not intersect at a point distant (precisely) 90°, etc.

Please give us a clearer explanation of this, and also, since you have introduced it, of what you mean by "exactly parallel." Very respectfully,

Robt. B. Stanton, M. Am. Soc. C. E.
Los Angeles, Cal., Jan. 15, 1894.

(Our correspondent is undoubtedly correct in his claim that a plumb-bob does not point precisely to the earth's center of gravity in any position except at the equator or at the poles. It is customary to consider that it does, and leads to no sensible error, but in order that the centers of attraction of any two bodies may coincide precisely with their centers of gravity it is necessary that a plane passing through the centers of gravity shall either divide each into two equal and similar masses or at least into two masses which, under Newton's law, exert an equal attraction on the other body. Since the earth is a spheroid, and not a sphere, these conditions can be fulfilled only at the equator or at the poles. At any other point on its surface a plane passing through a plumb-bob and the center of gravity of the earth will divide the latter into two dissimilar masses, one of which will exert sensibly more attraction on the plumb-bob than the other, because its mean distance from it is sensibly less.

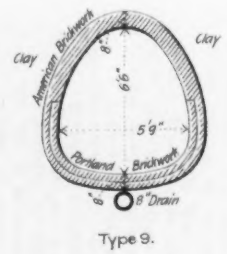
It still remains true, however, that two lines laid out "exactly parallel" (a term which we do not think needs any definition) on the surface of the earth, and 5 ft. or any other distance apart, and accurately prolonged by the transit, will be found to lie in planes which are very nearly those defined

Type 5.

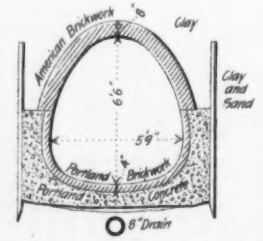
Type 6.

Type 7.

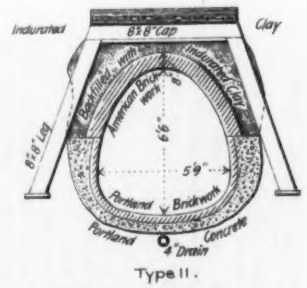
Type 8.



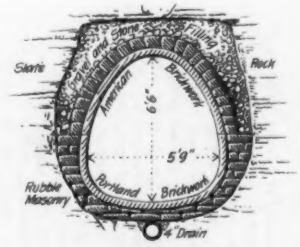
Type 9.



Type 10.

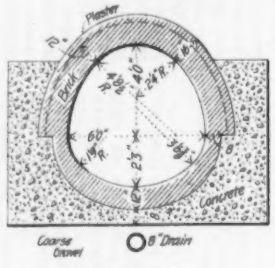


Type 11.

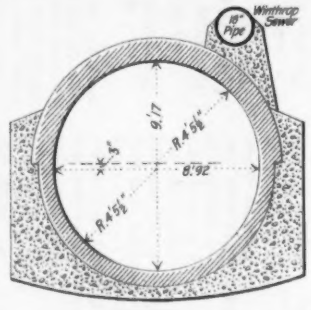


Section 27.

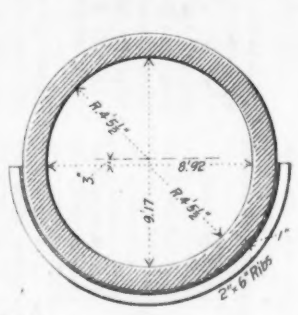
FIG. 2. CROSS-SECTIONS USED IN CONTRACT SECTION No. 26, AND CROSS-SECTION OF SEWER IN TUNNEL IN CONTRACT SECTION No. 27.

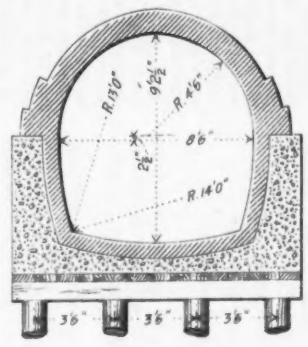


Section 2.

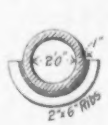


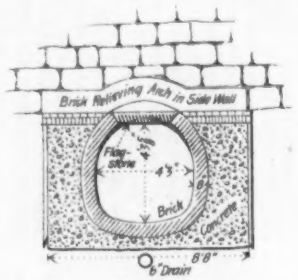
Section 4.





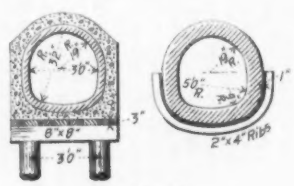
Section 5.





Section 21.
Culvert Crossing.

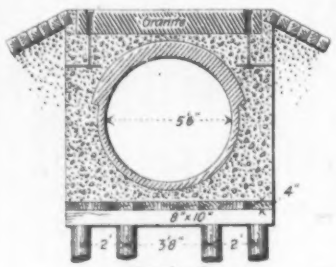
Section 20.



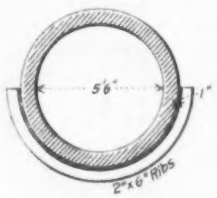
Section 22.

Section 41.

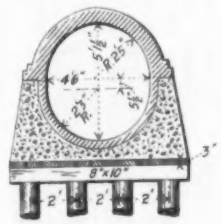
Section 43½.



Section B.
Under Muddy River.



Section B.



Section C.

Section E.

Section H.

FIG. 3. TYPICAL AND SPECIAL CROSS-SECTIONS EMPLOYED THROUGHOUT THE SYSTEMS.

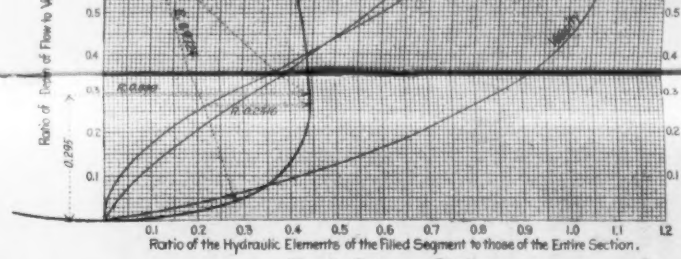


Fig. 6. Catenary Section.

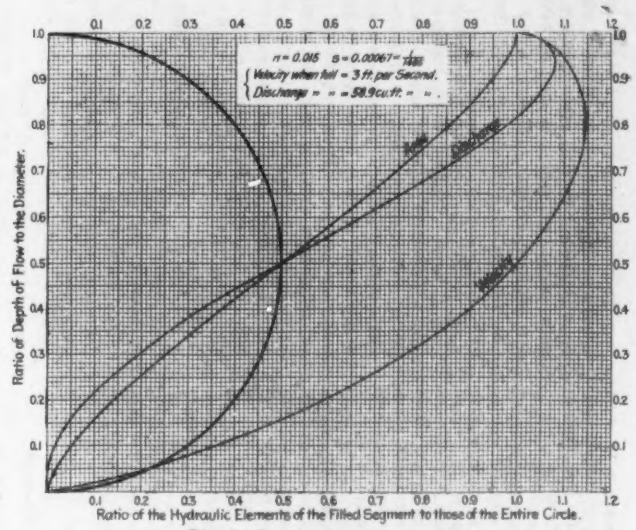

n = 0.015 s = 0.00067 = 1/1500
Velocity when full = 3 ft. per Second.
Discharge = " " = 58.9 cu. ft. = "
Ratio of Depth of Flow to the Diameter.
Ratio of the Hydraulic Elements of the Filled Segment to those of the Entire Circle.

Fig. 7. Circular Section, 5 ft. Diam.

FIGS. 4 TO 7.
DIAGRAMS SHOWING HYDRAULIC ELEMENTS OF DIFFERENT SEWER CROSS-SECTIONS, BY KUTTER'S FORMULA.

The Symbol ⊜ Denotes Equivalent Circle of Equal Carrying Capacity Flowing Full.

CROSS-SECTIONS OF SEWERS AND DIAGRAMS SHOWING HYDRAULIC ELEMENTS OF FOUR GENERAL TYPES, METROPOLITAN SEWERAGE SYSTEMS.

Howard Carson, Chief Engineer.
Hosea Kingman, Tilly Haynes and Harvey N. Collison, Commissioners.

CHAS. HART & SONS, LITH., 35 VESEY ST., N. Y.

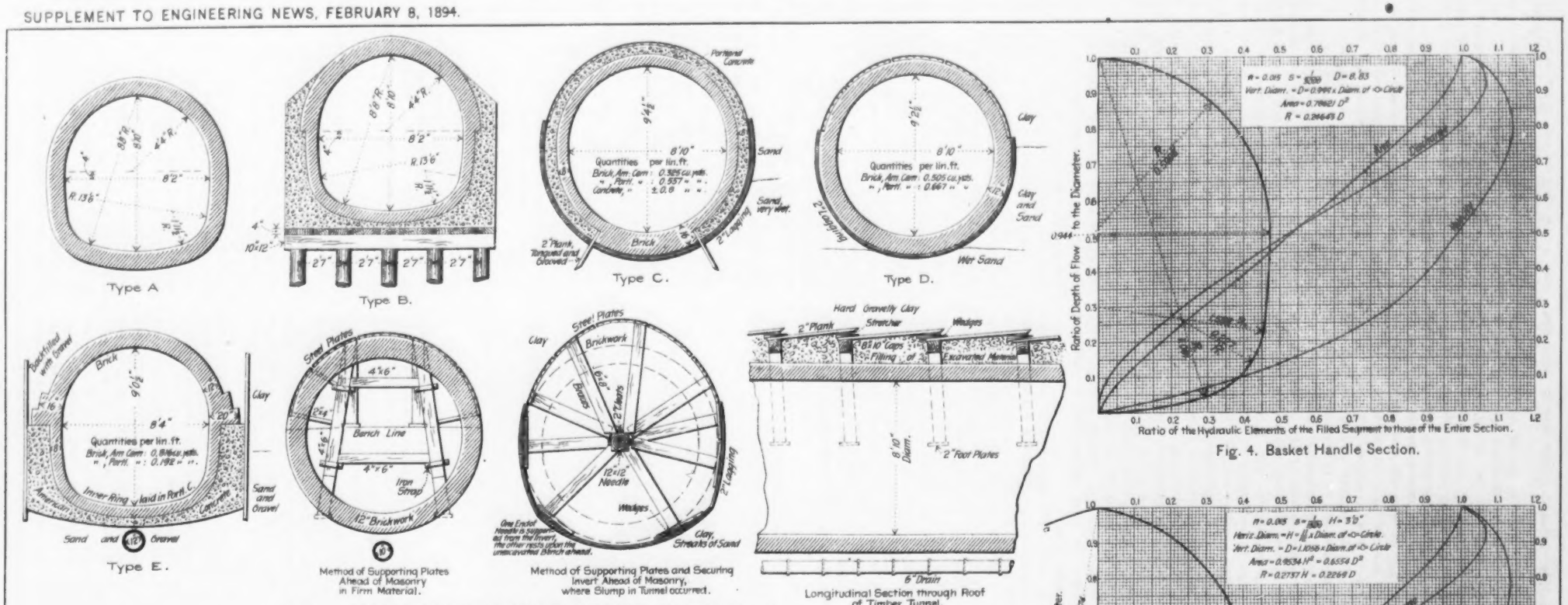

Type A
Type B.
Type C.
Type D.
Type E.
Method of Supporting Plates Ahead of Masonry in Firm Material.
Method of Supporting Plates and Securing Invert Ahead of Masonry, where Slump in Tunnel occurred.
Longitudinal Section through Roof of Timber Tunnel.

FIG. 1. CROSS-SECTIONS OF SEWER, CONTRACT SECTION No. 14, AND METHODS OF CONSTRUCTING TUNNEL.

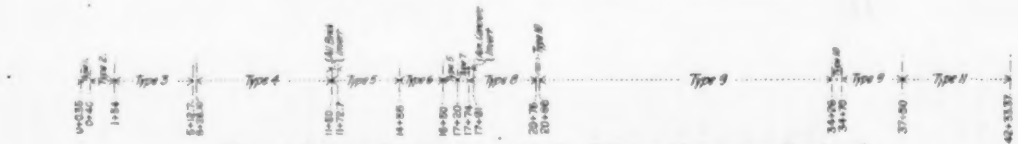
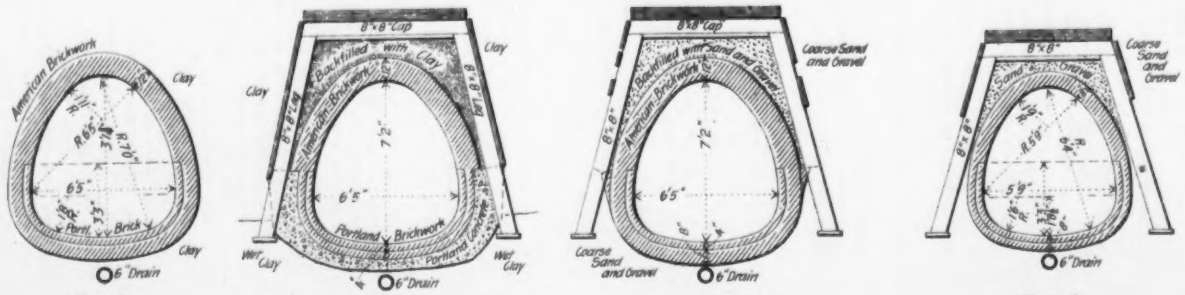
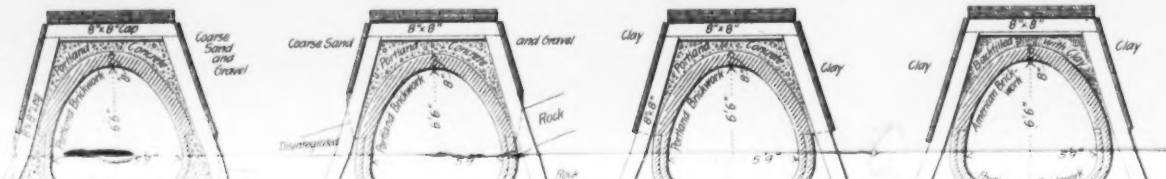


Diagram Showing Lengths for which the Different Types were Employed.





Ratio of Depth of Flow to the Diameter.
Ratio of the Hydraulic Elements of the Filled Segment to those of the Entire Section.

Fig. 4. Basket Handle Section.

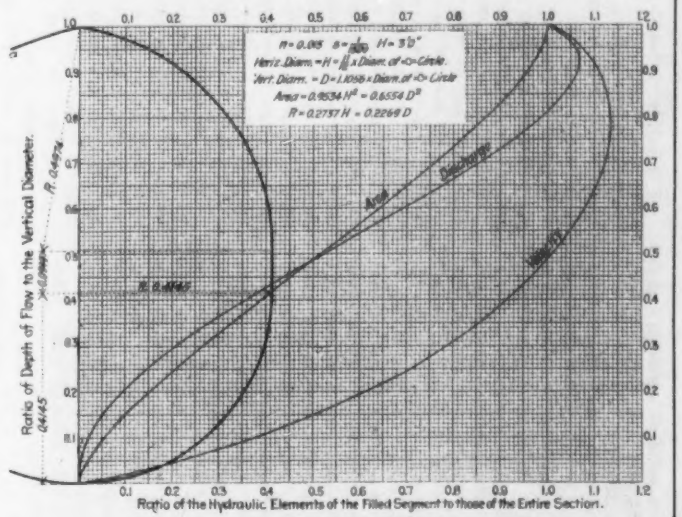
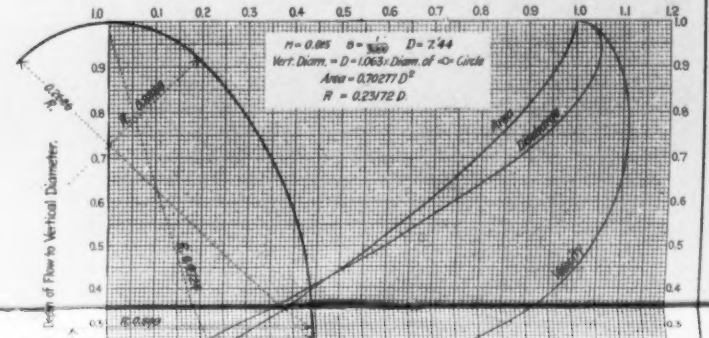

Ratio of Depth of Flow to the Vertical Diameter.
Ratio of the Hydraulic Elements of the Filled Segment to those of the Entire Section.

Fig. 5. Gothic Section.



by great circles, though not quite, because neither will quite pass through the center of the earth, and hence will intersect at a point which is sensibly 90° on the earth's surface from the starting point, though it may vary minutely therefrom.—Ed.)

IMPROVISING PROTRACTORS.

Sir: There are in general use at present several methods of laying off angles in plotting surveys, all of which, however, depend upon the presence of some extra table or instrument. There is an adaptation of the method of plotting by chords which would seem available under any circumstances. If a circle be described with radius 57.5 and be divided into 60° arcs by chords equal to the radius, and thest 60° arcs be subdivided into 30° arcs by chords of 29.8, any angle or bearing can then be laid off by finding the angle in degrees between the bearing and the nearest 30° point on the circle and using the resulting number as a chord from the 30° point. Thus to lay off an angle of 87° 42', the nearest 30° point is 90°, the angle between the bearing and the 30° point is 2° 18', and the chord to be used on the circle from the 90° point is 2.3.

Engineering News has been the means of introducing several exceedingly useful practical formulas, and it would seem to me that these figures, 57.5 and 29.8, being the essentials of a practically perfectly accurate method of plotting, which is always ready at any emergency, are worthy of being added to the file of those formulas.

I remain yours truly, J. G. Kerry.

Montreal, P. Q., Jan. 11, 1894.

(Our correspondent's 57.5 should be 57.3, and his method otherwise can be considerably improved, as follows: Striking a semi-circle with a radius 57.3 by any scale, spacers set to 10 by the same scale will divide the arc into 18 spaces of 10° each, and intermediates can be measured indirectly at the rate of 1 by scale for each 1°, or interpolated by eye according to the degree of accuracy required. This method gives any desired degree of accuracy and requires to keep in memory but one constant, 57.3, which most engineers have already in memory, it being the radius in stations of a 1° curve.—Ed.)

STANDARD SIZE FOR PAMPHLETS, ETC.

Sir: Referring to the recent action of the Master Car Builders' Association regarding standard sizes for pamphlets and catalogues, it is certainly unfortunate that for the smaller size 3½ × 6 ins. was recommended, instead of the more usual size, 4½ × 6 ins., the latter size being exactly one-half the medium one, just as the medium one is just one-half the size of the larger, 9 × 12 ins. In my opinion 3½ ins. is not wide enough, making the column of reading matter too narrow, for with a 3-in. column (which is narrow enough) the margins are only ¼ in. in width, and in binding one of the margins is further reduced.

The 4½ × 6 ins. is also more symmetrical, and looking at it from every point of view the most desirable size. It is to be trusted that this size, instead of 3½ × 6 ins., as recommended, will prevail.

Yours truly, Emile Low.

Saltville, Va., Jan. 29.

THE METROPOLITAN SEWERAGE SYSTEMS OF MASSACHUSETTS.

(With inset.—Continued from p. 63.)

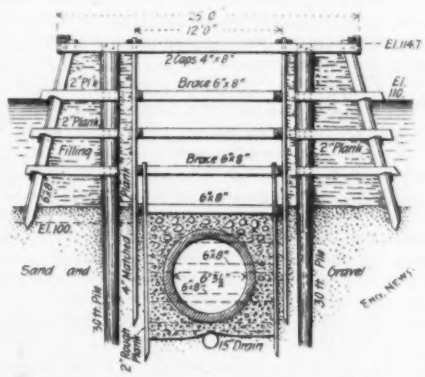
As might be expected, many different forms of cross-section and construction were necessary in connection with the Metropolitan sewerage systems, including, as they do, some 40 miles of sewers ranging from a general size of 9 ft. to 15 ins. in diameter, placed in almost every conceivable kind and combination of soil. Some 30 or more different cross-sections, either of a general or special character, are presented on the inset sheet in this issue, together with four diagrams showing the hydraulic elements of the four main shapes of internal cross-section designated as basket handle, gothic, catenary and circular. These diagrams are worked out in an interesting and ingenious manner and show the ratio of the hydraulic elements of any filled segment to those of the entire section, the area, discharge and velocity with the sewer flowing full being assumed as unity.

The contract sections of the two systems are numbered on the North Metropolitan system and are designated by letters on the Charles River Valley system, as indicated on the map published on our inset sheet of Jan. 25, 1894.

Sec. 1, or the outlet into the ocean at Deer Island, a cross-section of which at Station 5+00 is shown by the accompanying illustration in the text begins at a point on Deer Island, about 60 ft. inside the high water line, has a total length of 1,950 ft. and a diameter of a little over 6 ft. For the first 100 ft. the ground surface is above high water and the remainder is from 5 to 10 ft. below high water. This has necessitated the cofferdam shown in cross-section by the accompanying illustration. The pile bents are 6 ft. c. to c., and the last 100 ft. constructed during the year was spur-shored. The sheeting used for 336 ft. beyond the high water line was 2, and for the remaining distance, 4 ins. thick.

The excavation is done by means of buckets, traveling derricks and dump cars, the latter being emptied at the sides and end of the trench. Centrifugal pumps are used to keep water out of the trench, which is mostly leakage from the sea. The greatest amount pumped in 24 hours has been 1,100,000 gallons. The concrete extends up to the bed of the sea, boulders of the size of paving stones being imbedded in its upper surface.

Work on this section was begun about the middle of June, 1893, and to the end of the following



Cross-section or Contract Section No. 1, Metropolitan Sewerage Systems.

September 526 ft. of trench and 450 ft. of masonry had been completed. The average depth of excavation to bottom of underdrain was 14, and the maximum depth, 20 ft.; the average width of top of trench, 11.67, and of bottom, 10 ft. The trench averaged 5.6 cu. yds. of excavation per lin. ft. and the cost for trench to Sept. 30, including cofferdam, sheeting left in place and backfilling, was $44 per lin. ft., while for the work complete the cost was approximately $70 per ft. Underdrains were laid on this section as followo: 10 ft. of 6-in., 16 ft. of 8-in. and 500 ft. of 15-in. In common with some other especially difficult sections this part of the work is being done by the Commission with day labor.

Sec. 2, also on Deer Island, has a length of 2,136 ft., of which 1,615 ft. extends from the pumping station to the beginning of Section 1 and 505 ft. from the pumping station in the other direction, the former varying from 6×10 ft. at the pumping station to 6×6¼ ft. (see Sec. 2, Fig. 3, on the inset) and the latter being 9 ft. 1 in. in diameter. A gap of 310 ft. is left between these two parts for the pumping station. Excavation on this section was begun July 16 and masonry was finished Nov. 21, 1891. The average depth of excavation to the bottom of the underdrain was 17 ft. on the outfall and 28 ft. on the main sewer, and the maximum depths were 20 and 31 ft., respectively. In the outfall sewer the excavation amounted to 6.3 and in the main sewer to 11.4 cu. yds. per lin. ft. of sewer. The approximate cost of the trenching, sheeting left in and backfilling for both sections was $11.50 per lin. ft.; for masonry, including underdrain, $15.70; and for the whole work, including inspection and miscellaneous items, $29.15. The contract prices for masonry were as follows: Brickwork in American cement mortar, $12, and in Portland, $13 per cu. yd.; concrete, $4.95 and $6.25, respectively, per cu. yd. The contractors were the National Construction Co., of Boston, Mass., with Mr. Thos. J. Young as general manager.

At the beginning the trench was in sand and gravel, which admitted tidewater so freely that pumping was necessary. The arch and invert walls of the outfall portion of Sec. 2 are of brick, 8 ins. thick, surrounded by 8 to 16 ins. of concrete. As the outfall portion is to operate under a small head Portland cement was used both for the brickwork and concrete, and the arch was so loaded as to give an excess of downward pressure. Where water gave trouble the mortar for the masonry was made richer and in the worst places neat Portland cement was used. Part of the material found in excavating Sec. 2 was so tenacious as to require blasting.

For the work on Sec. 2 during the year ending Sept. 30, 1892, a Carson trench machine* was used on the outfall and an A-frame derrick on the main sewer. An embankment was carried to a height of 7 ft. above mean high water for 1,365 ft. of the length of the outfall sewer, and some 700 ft. of the embankment was protected by rip rap.

Sec. 3 extended along Deer Island to Shirley Gut, about 2,700 ft., at a trench depth of nearly 30 ft. More tenacious material requiring blasting was found and for the 1,600 ft. nearest the Gut the trench was in loose sand and gravel, through which the sea water percolated so rapidly as to require the use of three centrifugal pumps, 4, 6 and 8 ins. in diameter, respectively, and even these could not always keep out the water. To lessen leakage along this stretch the arch of the sewer was covered with a thin layer of clay. Excavation was begun in June, 1890, and the section was completed Aug. 1, 1891.

Sec. 3½ includes the siphon beneath Shirley Gut and will be described in a later issue.

Sec. 4 is 5,700 ft. in length. Two cross-sections on this part of the system are shown in the upper part of Fig. 3, each of the same internal size and shape, but one having a timber cradle and the other a concrete foundation, which permits of a thinner invert. An 18-in. Winthrop town sewer was relaid on a continuous pier of concrete over the arch of the Metropolitan sewer on this section, as shown in Fig. 3. The first brick were laid June 6, 1890, and the last June 3, 1891. During the first season the material excavated was in such coarse gravel as to allow salt water to rise and fall in the trench with the tide. It was estimated that as high as 4,500,000 gallons of water per day was pumped from the trench, the lift at the time being 24½ ft. During the second season the excavation passed through wet gravel again and also through compact silt, clay and gravel in a great variety of relative positions.

Sec. 5, 4,600 ft. long, lies in the town of Winthrop. The excavation was in peat, gravel and silt, to a quite uniform depth of 16 ft., with a top width of 16 ft. and bottom of 13 ft., making 8.6 cu. yds. of excavation per lin. ft., which cost, including backfilling, $10.80 per cu. yd. The size of the sewer is equivalent to a circle with a diameter of 9 ft. 1 in. Much pumping was required during the first part of the work. Some of the sewer rests on piles driven at random, about 3 ft. on centers, with the tops filled around with Portland cement concrete for a foundation. At the springing of the arch the masonry is 30 ins. thick and the spandrels are filled with Portland cement concrete. At a crossing of a tidal creek the arch was depressed 1½ ft. and the width increased accordingly, the sewer being reinforced at the spring line with side walls about 4½ ft. thick. Provision was made for removing sand deposits, should they occur, and the arch beneath the creek was covered with tar. More of the 18-in. Winthrop town sewer was taken up on this section and relaid as described above.

Across a marsh the sewer in Sec. 5 has a pile foundation, the piles varying from 20 to 40 ft. in length. Here sulphureted hydrogen sometimes rendered the workmen unable to remain long in the trench without inflammation of the eyes; and at spring-tides the diking out of water gave rise to much difficulty.

Masonry was first laid on Sec. 5 on June 26, 1890, and was finished Nov. 17, 1891, the Metropolitan Construction Co., of Boston, Mass., being con-

* These trench machines were used by the contractors without the payment of royalties, in accordance with an agreement made with the inventor, Mr. Carson, who is chief engineer of the work.

tractors, with Mr. Geo. W. Judd as foreman. A trench machine was used on this section. An 8-in. pump and 12-in. underdrain were employed to keep the trench free from water and silt was deposited over the arch to lessen percolation. For the latter part of the work the sewer rests on a foundation consisting of piles about 20 ft. long, in bents, capped with 12×14-in. timber, and supporting a 4-in. platform. With one gang of men the ordinary progress the last season of the work was 72 ft. per week. Sec. 5, in Fig. 3, shows the sewer on pile foundation, but the exact location of this cross-section on Sec. 5 cannot be stated.

The contract price for masonry on Sec. 5 was as follows: Brickwork in American cement mortar, $12.95, and in Portland $14.85 per cu. yd.; concrete, $4.30 and $5.94, respectively, per cu. yd. The approximate cost of masonry, piles, platform and underdrain was $21.90 per lin. ft., and the approximate total cost of the sewer was $35.70 per lin. ft.

Sec. 6, also in Winthrop, is about 4,135 ft. long. Brickwork was begun June 18, 1890, and finished Sept. 14, 1891. A part of this section was in clay suitable to receive the invert without a special foundation. The sand in the clay gradually increased until water burst through the bottom in streams. The sand was very fine and a troublesome quicksand was formed.

Sec. 7 is not yet completed. It is known as Belle Isle Inlet and includes a siphon, sand catcher, pipe chamber and approaches which we hope to describe in a later issue.

Sec. 8 is 4,726 ft. long and includes 3,266 ft. of circular sewer, 9 ft.×9 ft. 2 ins., 746 ft. of horseshoe 8½ ft.×9 ft. 2 ins. and 114 ft. modified to pass under pipes. A part of the distance clay suitable for an invert was found. For 300 ft. from Belle Isle Inlet west, the excavation having been in peat, the sewer rests on an 8 to 20-in. bed of Portland cement and has an 8-in. brick invert with Portland concrete side walls. Mr. Charles Linehan, Cambridge, Mass., was contractor. Masonry was begun Sept. 4, 1890, and practically finished June 23, 1892. The average depth of excavation to bottom of underdrain was 16.4 ft. and the maximum 23 ft. There were 8.8 cu. yds. of excavation per lin. ft., which, with backfilling, sheeting, etc., cost about $8.20 per foot of sewer. Brick were furnished the contractor by the Commissioners and laid in American cement mortar for $6 and in Portland for $7.25 per cu. yd. American concrete cost $4 and Portland $4.50 per cu. yd. The masonry cost about $17.40, and the whole sewer about $28 per lin. ft. During the year ending Sept. 30, 1892, a steam derrick was used.

Sec. 9, like Sec. 8, is in East Boston, includes 3,383 ft. of sewer, of which 2,018 is circular and 1,365 ft. horseshoe section, the dimensions and contractor being the same as for Sec. 8. In the main the work was much like that on Sec 8, but cost a little more, and was practically completed at about the same time. For some 900 ft. a trench machine was used and for about 250 ft. of light cut the material was thrown out by hand. For some distance it was necessary to remove peat to a depth of from ½ to 6½ ft., and place a bed of concrete on the underlying clay to form a foundation.

Regarding the general character of the masonry walls of the sewers, as built to Sept. 30, 1890, the report of the engineer for the year 1889-90 states as follows:

> The 9-ft. masonry sewer referred to in the foregoing paragraphs has an interior surface of hard brick. The walls of this sewer are from 12 to 33 ins. in thickness at the springing line of the arch. Where the wall is of the minimum thickness alluded to it is composed entirely of brickwork. The thicker walls which in general form the sides of the sewer are composed of brickwork backed with concrete. The varying thickness of the brick and concrete masonry depends mainly on the character and position of the earth formations which surround the sewer. The lightest walls are usually in clay. In sand and silt they are successively thicker and are thickest in soft peat.

Sec. 10, built by day labor, includes a siphon under Chelsea Creek and the East Boston and Chelsea pumping station. It has a length of 709 ft., 504 of which is a tunnel 5⅔ ft. in diameter. This section is not completed and deserves a more detailed description than can be given at this time.

Sec. 11 is a short branch sewer for which contracts have not been let.

On Sec. 12 serious difficulties with water were encountered, requiring special treatment, which we hope to describe in a later issue.

Sec. 13 appears not to have been established as yet.

Sec. 14 is 3,445 ft. long and included some difficult deep cut and tunnel work, there being 1,850 ft. of trench and 1,586 of tunnel. The masonry in the tunnel was begun April 14, 1892, and finished May 25, 1893; the masonry in trench was begun June 2, 1893, and finished Aug. 14, 1893. There are 1,586 ft. of 8 ft. 10-in. sewers, 1,749 ft. of 8⅓×9-ft. and 110 ft. 8 ft. 2-in.×8 ft. 10-in. The Metropolitan Construction Company, of Boston, were contractors, with Mr. George W. Judd as foreman.

The open cut work was done by means of Carson trench machines, and the tunneling with the aid of tram cars and cages. In some of the trenching water gave much trouble, and after centrifugal pumps would no longer answer its level was lowered by a driven well pumping plant, as on Sec. 12. In some of the wettest places the masonry of the bottom of the invert was increased to 20 ins. in thickness. Some of the trench was 37 ft. deep, requiring great skill in bracing. The least distance from the sewer arch to the ground surface is 12 ft. In one street a 12-in. local sewer was replaced upon a gravel filling above the Metropolitan sewer and for another stretch a 24×36-in. brick sewer was replaced by 24, 18 and 15-in. pipe sewers upon either gravel or platform foundations. Some or all of the platform foundations were supported by posts resting on piers built upon the arch of the Metropolitan sewer. During this operation the dry weather flow of local sewage was carried in an iron pipe and during storms an overflow into the sewer trench was permitted. For that part of the sewer built to the end of September, 1893, all but 184 ft. had the bottom of the excavation made to fit the sewer invert. In trench the progress during the year 1891-2 was 48 ft. per week and during 1892-3 about 40 ft. The sewer in trench is shown by Types A, B and E, Fig. 1. Type A shows the sewer wholly of brick; Type B, reinforced with masonry on a timber platform supported on piles; Type E, in sand and gravel below the center line, with clay above.

In the tunnel work carried on during the first year the full bore of the tunnel for the first 300 ft. from the Pearl St. shaft was made to exactly fit the brickwork, as shown in Type D, Fig. 1, the upper part being secured by ⅛-in.×1×3 ft. curved steel plates, bolted to each other and supported by 8×8-in. temporary posts. Later the contractors substituted timber sets for the plates, which were used until difficult work was struck in 1892-3, consisting first of fine running sand at the bottom and a little further on of soft clay at the top. The trouble with soft clay was precipitated, perhaps, by the flooding of the tunnel during a heavy storm, when the clay on which the timber roof was supported become soft and allowed the legs to settle through it into the sand, causing the street surface to settle 3 or 4 ft. for a length of 35 ft., but causing no further damage. After this work air pressure was used and the roof was lined with flanged curved plates bolted together similarly to those described above. The method of supporting the steel plates ahead of masonry in firm material, and also at the point where the slump occurred is shown at the bottom of Fig. 1, an axial or needle-beam having been used in the latter case.

The progress with the troublesome bottom was only 16.7 ft. per week. With the compressed air and steel plates the first 230 ft. was done at the rate of 22.9 ft. per week, but further on progress was slower, bringing down the average to 16 ft. per week. One air compressor after another was added, owing partly to escaping air, until five were in use, the approximate amount of air compressed increasing from 135 to 1,400 cu. ft. per minute. At one point with all five compressors running the excavation could be carried only to within about 1½ ft. above the bottom of the masonry, the ground below being saturated with water. To quote from the report of the chief engineer for Sept. 30, 1893:

> It was then suggested that as the leakage of air was at the top the air might be held in sufficient quantity to allow excavating the bottom and laying the masonry by starting as low as possible and putting in a concrete lining to the sides, roof and heading (as in Type C, Fig. 1.—Ed.). This method of holding the pressure was successful. It was then thought that if the arch was built first the same result might be obtained without the use of concrete, and this proved to be the case. The arch was built on wall plates, and these and the arch were supported by braces from the axial or needle-beam in the same manner as were the plates. The invert was then built up to the wall plates, which were taken. The space so left was filled with brick. After building 46 ft. in this manner clay again appeared in the bottom and work went on in the regular way.

The cost per lineal foot of completed work on this stretch was $56.90, with 16-in. masonry, and in the headings where air was not used, with 12-in. masonry, $46.37.

In addition to the cross-sections on Fig. 1, to which reference has already been made, there is a longitudinal section showing the timber roof to a short heading. This piece of tunnel was all in clay, which was shaped to the invert, and on it the progress was about 25 ft. per week.

On this section, No. 14, the average depth of trench excavation to the bottom of the underdrain was 28.6 ft., and the maximum 37 ft. The corresponding tunnel depths were 37 and 45.5 ft., respectively. The average width of the trench at the top was 14.5, and at the bottom 12.1 ft.; while the average width of the tunnel was 11.1 ft. The average trench excavation was 14.5 and of tunnel 4.2 cu. yds. per lin. ft. The approximate cost of trench and tunnel, including sheeting and backfilling, was $28 per lin. ft., and the total cost of the section was $50.50 per lin. ft., with some claims still pending. The contract prices for work on this section were as follows: Brickwork in trench, American cement mortar, $12.11, in tunnel, $13.94 per cu. yd.; with Portland cement mortar, $14.06 in trench and $16 in tunnel. Concrete in trench, American cement, $4.92, in tunnel, $5.98 per cu. yd.; with Portland cement, $6.88 in trench and $9.25 in tunnel.

Passing for the present from contract Section No. 14 to No. 26 it may be seen from Fig. 2, on the inset sheet, what a variety of cross-sections, eleven in number, were necessary in this contract section of less than a mile, from which fact some idea may be gained of the magnitude of the work involved in designing the system and the care with which the material has been studied and the construction suited to it.

The total length of Sec. 26 is 4,233 ft., of which the last 483 ft. (Type 11, Fig. 2) was done by day labor in connection with a shorter length of Sec. 27. Throughout the greater part of the contract work the material was such as to allow the invert to be built directly in the excavation without special foundation, as will be seen in Fig. 1. In fact nearly half the section was in clay, which permitted an all brick section, but the balance was clay of such consistency, or in sand and gravel, as to require the various forms shown in Fig. 2, all of it save some 300 ft. covered by Type 10 being protected by a timber platform, with backfilling of clay or concrete between the platform and the sewer.

The first 3,750 ft. of Sec. 26, or the contract work, included 530 ft. of 6 ft. 5-in.×7 ft. 2-in. sewer and 3,220 ft. of 5¾×6½-ft. sewer. Of the larger sewer 48 ft. was in trench and 482 ft. in tunnel, and of the smaller 1,674 ft. was in trench and 1,546 ft. in tunnel. The average depth of the trench to the bottom of the underdrain was about 23.5, and the greatest, 29.5 ft. The average and maximum depths of the tunnel to bottom of underdrain were 34.3 and 36 ft. for the larger and 28.8 and 32.8 ft. for the smaller, respectively. The total cost of the sewer complete for the whole section was $23. The contract work was finished April 11, 1893, and the day work on Sec. 26 and 27 a little earlier.

In the lower left hand corner of Fig. 2 is given a cross-section of a short length of sewer in rock tunnel, built by day labor on Sec. 27 in connection with the day work on Sec. 26, mentioned above.

Of the miscellaneous cross-sections on Fig. 3, to which reference has not already been made, the two cross-sections of 2-ft. sewer on contract section No. 20 relate to the Edgeworth branch in Medford, which is 1,523 ft. long, comprised 2.6 cu. yds. of excavation per lin. ft. and cost $6 per lin. ft., complete. The double timber cradling on this trench, shown in Fig. 3, was used

where much water was encountered, and the concrete reinforcement of the invert through the remainder of the branch. At and adjoining a creek crossing, peat and silt were removed for 240 ft. to a maximum depth of 7 ft. to the underlying clay, and the space refilled with gravel and broken stone Portland concrete.

On Sec. 21 a culvert was carried over the sewer as shown near the end of Fig. 3, a flagstone being let into the crown of the sewer and the latter being reinforced at each side of the channel by brick arches in the sidewalls of the culvert. On this same section the sewer, which at this point is $4\frac{1}{3} \times 4\frac{1}{4}$ ft., is carried over a creek in a 4-ft. iron pipe, $9\frac{3}{4}$ ft. long, extending between two walls of coursed granite. At low tide the stream passes under and at high tide it may pass both over and under the pipe. The creek bed is paved with granite blocks laid in a bed of concrete. Cast iron sleeves are provided in the sidewalls so the pipe may be renewed without disturbing the masonry. An overflow with double tide gates is provided here and also stop-plank manholes in the sewer. The cost of the iron pipe and sleeves delivered in Medford, and the masonry, was $11,220. The work was done by the day.

The detailed descriptions which have preceded render unnecessary special comment on the five cross-sections of contract sections Nos. 22, 41 and 43½, Fig. 3. The five cross-sections at the bottom of Fig. 3, designated as Secs. B, C, E and H, are presented to give some idea of the work on he Charles River system, which was completed about two years ago and has been in use for some time.

The illustrations accompanying this article were made from drawings furnished us by Mr. Howard A. Carson, Chief Engineer of the Metropolitan Sewerage Systems, and the text has been abstracted from the very complete annual reports of Mr. Carson, which for fullness of description of the essential features of the work and full and clear presentation of figures relating to size and cost are to be commended to all engineers having to do with such undertakings.

LINING A WATER-WORKS TUNNEL WITH CONCRETE.*

The Sudbury River aqueduct, supplying Boston with water, extends from Farm Pond, in South Framingham, a distance of 15.9 miles, to Chestnut Hill reservoir, in Boston. It is 9 ft. wide, 7 ft. 8 ins. high, and has a fall of 1 ft. to the mile and a capacity of 100,000,000 gallons daily. Near the reservoir it passes through a tunnel in conglomerate rock for nearly one mile. The conglomerate is crossed in places by strata of slate. This slate underlies the Boston basin. In 1877 it was found that disintegration had begun at a few points, and a side wall 50 ft. long was built in the tunnel, and 260 ft. of brick arching in two separate sections. A report by Professor Pompelly at this time says: "The axis of the tunnel is nearly in the direction of the course of the bedding; the slate is much broken, and small quantities are liable to fall in, although it does not endanger the safety of the tunnel. Two points in the tunnel need attention. The first is where there are several joints in the roof running nearly in the direction of the tunnel and converging upward. The conglomerate has undergone decomposition to the depth of several inches, and this, together with the positions of the joints, renders the roof and walls at this point insecure. At the second point the roof has caved in to the height of 18 to 20 ft., owing to the horizontal columnar structure of the rock. The walls are good, and it seems as though they might be left undisturbed for the present."

For several years after this report was made, portions of the roof gave way, and it became evident that it was only a matter of time when it would be necessary to line portions of the tunnel. In June, 1888, six cartloads of rock were removed, and before the close of the year a large number of heavy pieces fell. It was decided, therefore, to begin repairs at once. During 1890, 20 cartloads were removed, and in the summer of 1890, during the work of lining the tunnel, a mass of rock weighing fully ten tons fell, demolishing the track and injuring the switch, but, fortunately, injuring no one. Other dangerous portions were braced up until they could be permanently supported by the lining.

As it was necessary to mainthin the supply of water to the city during the process of lining, it was realized that the work would be difficult. Cross-sections were taken, and in one place it was found the roof had fallen to such an extent as to be 10 ft. above the average roof line. An estimate of cost for lining the tunnel was based on 650 ft. in length of the most dangerous portions, requiring 2,500 cu. yds. of concrete. The scheme as developed consisted in laying a track 2 ft. above the bottom of the tunnel, upon which special cars were to run for transferring the materials for the Portland cement, so that it could be mixed close to the centers. The centers were to be so designed that the cars could pass through them and allow, also, large flows of water. There are three points of access: one at the westerly end, one at the manhole near the easterly end, and the third through a second manhole. Shanties were erected at the manholes; a ledge was opened in Newton Center, a crusher set up, and about 50 tons of old rails provided for the track. It was determined to make the track as perfect as possible, and it was fortunate that this was done, as it never gave trouble and is in good condition after several years' use. The gage was 2 ft. 1¼ ins. The rails were slid down on an inclined plane to the floor of the aqueduct, and were carried on cars prepared especially for the purpose, having iron wheels covered with broad oak rims, beveled to conform with the invert of the aqueduct. Guide wheels, front and rear, projected to the sides of the aqueduct, to keep the cars in the center. Twelve rails were transported at a load. Arriving at the westerly end, they were transferred to a two-wheeled cart, carrying four rails at a load, and by this means were distributed along the line. These wheels were also covered with oak rims. The rails were carried an average distance of about one mile, and, when finally placed, had been loaded and unloaded 13 times, a part of the work having been done in water 1 ft. deep.

The rails were supported on 500 trestle frames 8 ft. on centers, which were made outside and transported by the same method. The fall of the aqueduct in the length of the track was 5 ins. This was increased 5 ins. so as to make a total fall of 13.7 ins., to make the work of pushing a full car easy. The trestles were of 3 × 4-in. spruce joists. Two vertical supports were placed directly under the rails, joined between the horizontal and vertical members by means of 1 × 3-in. strips, fastened with wire nails. One-third of the trestle caps were made long enough to extend out to the side of the tunnel, where they were wedged to keep the track in place, and the extremities of these pieces were braced down from above to keep the track from being floated. Suitable switches were made at points which would permit of their construction, and were provided with red and green lanterns for signals. The total cost of the work was $3,324.

Ten cars were used, seven for transporting material, two for concrete and one for miscellaneous use. The capacity of the stone cars when full was five barrels of crushed stone. The ends of the boxes were made slanting, to facilitate emptying. The three cars for cement and sand were fitted with similar boxes and divided by a partition to separate the sand from the cement. These held exactly two barrels of cement and four barrels of sand.

As no bracing could be used in the centers, they were made of great strength. They were intended to be spaced 2 ft. on centers, but this was increased to 4 ft., and they were found to be amply strong. They were built of spruce planks, breaking joints and nailed with 4-in. wire nails, and when completed measured 5¼ ins. wide and 10 ins. deep. They were in three parts, secured together by bolts. The two side sections, when in position, extended from the bottom of the tunnel to 4 ins. above the spring line. The upper part was 6 ins. short of a full semi-circle. A 2-in. space allowed the introduction of wedges between the upper and lower sections. When set up, the side sections met in center of the tunnel and were separated by a wedge. The lagging was made from 2 × 4-in. spruce joists in 8-ft. lengths so used as to form a tight cover over the centers.

It was found that the work of lining the tunnel could be carried on better in winter than in summer. This was contrary to what was expected, but it was necessary for the laborers to wear heavy clothing for protection, and the heat from torches and lights was considerable, and the space for working very cramped; hence, there was less discomfort to the men in the winter when the air was fresh and ventilation good.

After a little experience it was found perfectly feasible to supply concrete free from frost in the coldest weather. This required considerable storage room in the shanty, which was arranged to hold 500 barrels of cement, 160 cu. yds. of sand, 80 cu. yds. of crushed stone, and 80 cu. yds. of screenings. In the sand compartment a large stove was surrounded by a deep plank bulkhead lined with iron, and the sand piled all around it. By keeping up a fire, the sand was kept free from frost in the coldest weather. The crushed stone was covered with canvas to keep out rain and snow. There were four mixing beds, each 15 × 5 ft. and 10 ins. deep, and so built that the boxes containing the material on the cars projected over and prevented waste in loading and unloading.

Work could be carried on but four days in the week, for the reason that on the other three days a large flow of water had to be run to make good the loss in the reservoir; hence, the tracklaying occupied the greater part of the summer, and it was not until Oct. 15 that actual construction began. Work began on the bottom, as it was not thought wise to build the lining on top of the concrete floor with the dry filling underneath. To cut all the sides out would cost a large amount; hence, pieces were cut out 8 ft. long with an 8-ft. space between them, and breaking joints on each side of the tunnel. The faces of the piers were stopped 2 ins. short of the face of the lining, thus breaking the joint over the edge of the opening. All the filling under the concrete floor, consisting of broken stone, gravel, sand and clay was removed to the solid rock. Sand bags were laid around these excavations, but the water came in so rapidly as to require constant pumping. The average pier contained 16 cu. ft. of concrete.

A dam was built to regulate the flow of water and to prevent flooding. The top of the dam was 2 ins. below the bottom of the rails of the track. This accumulated the waters of percolation until they were raised sufficiently high to reverse the flow and cause the water to escape. By this means also an abundant supply of water was always at hand for making concrete, and the water was thus kept at its lowest point where the centers were being placed. The whole number of men employed, including the superintendent, was 41.

Portland cement concrete was used throughout. It was found that in dropping 12 ft. down the spouts to the car, some consolidation of the crushed stone and sand took place. As two barrels of sand were always emptied down the spout into each car, these two barrels remained unchanged, but rather more than four barrels of sand were shoveled down, to fill the sand compartment of the car. There was a shrinkage of 7% in the sand, and about 9% in the crushed stone. The concrete as used in the tunnel required about 1 3-10 casks of cement for 1 cu. yd. of concrete. With every barrel of cement there was used 18.56 cu. ft. of crushed stone, and 7.35 cu. ft. of sand, and these made 20 cu. ft. of concrete when thoroughly rammed. Very great care was taken in mixing the concrete to do it thoroughly. About 192 barrels of material were put in the work daily.

The concrete was put in place with shovels and rammed with rammers of oak and iron in various forms. It was pressed into the cavities in the roof with long-handled T-shaped implements made of 3 × 8 in. iron, and great care was required in this part of the work. In rainy weather large quantities of water poured from the roof and it was found necessary to build weeping drains into the concrete. These were built of spruce boards 6 ins. wide, in 4-ft. lengths, and were placed on both sides of the tunnel, 16 ft. apart. Bulkheads were placed usually 16 ft. apart, lengthwise of the tunnel, to hold the concrete in place while it was rammed and during settling. Bulkheads for the arch were 4 ft. apart. Spaces were formed in each section of the concrete lining by means of bulkheads 1 to 2 ft. wide, and 20 ins. high, thus forming a bond between the sections. Careful arrangements were made to supply water to the city at necessary intervals. The total expenditure for lining the tunnel was $55,685. This makes the cost of the concrete $16.08 per cu. yd. The track is still in the tunnel ready to be used again should any other portions require repairs in the future.

* Abstract of a paper by Mr. Desmond FitzGerald, read before the American Society of Civil Engineers, Feb. 7.

WATER PURIFICATION IN AMERICA.

(Continued from p. 86.)

A Cheap Covered Reservoir at Albany, Ga.,

What might be termed a negative purification is often necessary or highly desirable in connection with water supplies, especially those from artesian wells, which when exposed to the light give rise to troublesome algae or other growths, but when kept in the dark are satisfactory in character. Such purification or prevention of objectionable growths has been effected at Albany, Ga., in connection with a small storage reservoir, and was described before the New England Water-Works Association, on Jan. 10, 1893, by Mr. John C. Chase, M. Am. Soc. C. E. The description, slightly abbreviated, was as follows:*

The city of Albany, Ga., derives its water supply from artesian wells, but the hourly flow not being

* This paper will be published in full in a future number of the Journal of the New England Water-Works Association.

equal to a possible maximum hourly draft, it became necessary to provide for a storage of about 250,000 gallons. The city lot on which the pumping station and water tower were to be erected had a frontage of only 105 ft., with a depth of 210 ft., and with this limited area it was decided to build a circular basin 60 ft. in diameter, with a depth at the side wall of 13 ft., the bottom having a uniform slope of 1 ft. to the center. On account of the expense of disposing of the material excavated, the structure was built only about one-half in excavation. The excavation was in a very compact red clay, so hard in fact that the city in building cisterns 15 ft. deep and 18 ft. in diameter for fire engine supply have merely plastered the vertical side of the excavation with hydraulic cement mortar, using a brick dome of about 5 ft. rise for covering.

In this hard material it was practicable to build a very light lining wall, 16 ins. in thickness, which rested on a slight footing course about 8 ins. below the bottom of the reservoir. The excavation was cut out very carefully about ½ in. larger than the exterior of the wall. In laying the brick Portland cement was used for the inside course and Rosendale for the other three courses, and the ½-in. space outside of the brickwork was flushed full of cement, so that practically it is an earthen well lined with brick. The wall was carried about 6 ft. above the natural surface of the ground and received a coating of cement mortar on the outside. The excavated material was filled back against the wall, being deposited in layers, dampened and thoroughly rammed. The filling was carried to a point 1 ft. below the top of the wall and finished with a berm of 4 ft. and a slope of 1½ to 1. The lining of the bottom was a course of brick set on edge in a bed of Portland cement mortar, with joints of the same material. It was intended to cover the interior surface with a coating of Portland cement grout applied with a brush, but through some misunderstanding it was plastered with ¼-in. of Portland cement mortar. The character of the water was such that it was necessary to exclude the sunlight and a wooden roof seemed to be the cheapest and most feasible device. A brick pier 20 ins. square was built in the center of the reservoir, which carried one end of twelve principal radial trusses with 8 ft. rise, made of 1½ × 10-in. yellow pine plank. The chords and rafters were made up of two thicknesses of plank, separated by the diagonal members, the whole being securely fastened by bolts and spikes. The covering was of ¾-in. weather boarding, 9 ins. wide and laid 6 ins. to the weather. The butt joints at the ridges over the trusses were covered with a flashing of tin as each course of the weather boarding was put on and on completion the roof received two coats of mineral paint. It is designed to cover the roof with metal when the present covering begins to show signs of decay. The roof is surmounted by a hexagonal cupola. There are suitable openings in the cupola and at the eaves for ventilation, protected by galvanized wire screens. The roof water falls from the eaves into a shallow paved gutter and is carried down the bank by three lines of 6-in. drain pipe, in order to preserve the slope. The supply from the wells is carried over the top of the wall and a suitable overflow pipe is provided. Also a drain pipe, which, starting from the center, will permit of entirely emptying the reservoir. The pump supply is drawn from near the bottom and on the opposite side to the inflow pipe. The reservoir has been in use some 15 months and is believed to be thoroughly water-tight. It has been filled and emptied several times, showing no signs of bulging or distortion, and with the precautions taken to prevent surface water from finding its way down behind the wall, and to keep the contents from leaking out, it is hard to conceive of any hydrostatic pressure ensuing, tending to rupture the sides or bottom. The detailed cost was as follows:

101,500 brick at $4.75	$483
78 bbls. Portland cement at $2.90	226
51 bbls. Rosendale cement at $1.65	84
103 loads of sand at 50c.	51
Labor of excavating and bricklaying	612
Incidentals	12
Contract for roof complete	309
Total	$1,778

The work was all done by the day excepting the roof, which was contracted for. The prices paid were: For unskilled labor, 75 cts.; masons, $3; foreman, $4, and the day's work averaged about eleven hours. This fact and the low price of brick will account in part for the low cost of construction. Snowfalls being very light and infrequent, permitted a much lighter roof construction than would be possible in less favored localities. The full capacity of the reservoir is about 280,000 gallons.

RESISTANCE OF SOILS TO EROSION BY WATER.

By William A. Burr.

There are two classes of matter composing all soils, organic and inorganic. The organic matter is the decomposed animal or vegetable matter at the surface, known as humus, and the inorganic is purely mineral and consists of variable proportions of sand, clay and soluble salts. The specific gravity of the organic matter is always less than 1, and it therefore will float in water and will have absolutely no value for structures in contact with water. As the soluble salts will dissolve, they have no value. We have left then the sand and the clay, and as the specific gravity of each is greater than 1, each has more or less resistance to erosion.

As the specific gravity of clay is greater than that of sand, it is better able than sand to resist erosion, and will remain stable under water at a greater velocity. This is proved by experiment, as a velocity greater than 1.1 ft. per second will erode sand, while pure clay will stand a velocity of 7.35 ft. per second.

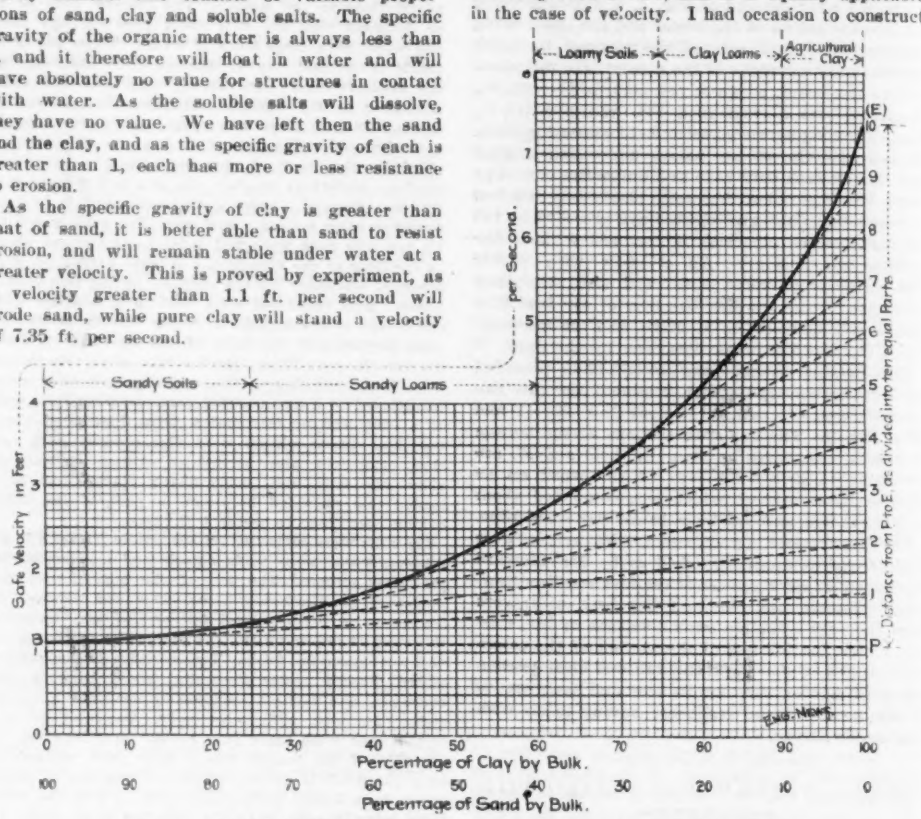


DIAGRAM FOR DETERMINING RESISTANCE OF VARIOUS SOILS TO EROSION.
(Patent Applied for.)

In view of the foregoing it will be seen that the greater the proportion of clay carried by any soil, the higher the permissible velocity, and a long series of experiments has shown me that the line describing the power of soils to resist erosion is parabolic.

As I have shown, and no doubt the practice of many others has shown, the value of soils for hydraulic purposes depends entirely upon the proportions of sand and clay, and that being the case, soils should be designated by us by means of characters representing those proportions. For instance, if the soil carries 80% clay and 20% sand, it should be described as C.80, S.20 and so on.

The analysis of soils to determine these proportions is very simple. The organic matter is first removed by burning in an open flame and the soluble salts are dissolved by stirring in a large glass graduate. After settling the water is poured off, carrying with it the soluble salts in suspension. The sand and clay will have settled in the graduate in two layers, the sand being on top and plainly distinguishable from the clay, and by the graduations on the glass the proportions can be readily computed.

In the accompanying diagram let the vertical lines represent the percentages of sand and clay and let the horizontal lines represent the safe velocities in feet per second.

We know from experiment that the safe velocity over pure sand is 1.1 ft. per second, hence the point B will be one point on the curve of safe velocities. We also know from experiment that over pure clay 7.35 ft. per second is a safe velocity, hence the point E will be the opposite end of curve. As above stated, my experiments have shown that the curve connecting these two points is a parabola, and we therefore proceed to find intermediate points on it by the following method: From B, the vertex of the parabola, draw a tangent cutting the ordinate through E at P. Divide P E into 10 equal parts. Draw the line B 1 and the point where it cuts the second ordinate will be a second point on the curve. Similarly the point where the line from this second point to 2 cuts the next ordinate will be a third point on the curve, and so on.*

The value of clays for the purpose of puddling has long been known, and it is equally applicable in the case of velocity. I had occasion to construct a canal for placer mining, in Lower California, through a soil of C.30 S.70, which in many places would stand a velocity of but 1.5 ft. The water carried considerable silt, which would precipitate with a velocity slower than 2.5 ft., and consequently fill the canal. To overcome this difficulty I simply placed a 2-in. layer of clay loam of about C.85 S.15 over the sandy places and at the end of a year the canal had carried a velocity of 2.75 ft. per second without erosion.

Again, on embankments forming the distributing reservoir of the South Gila Canal Co., of Arizona, which were built in very sandy soil and subjected to high winds which shifted many yards of material during construction, I induced the contractors to cover their embankments with a thin layer of clay, which they did with apparent willingness, but upon my return to the works after an absence of a month, caused by illness, I found that this had been discontinued. Upon examination I found that where the clay had been used, the embankments were in as perfect a state as when first completed, while where its use had been abandoned they were shifted by the wind, and deeply cut by rains which had visited the place since my absence. As these embankments were in many places 50 ft. in height, having a 2 to 1 slope, I consider that the velocity must have nearly reached the maximum.

*The parabola used is "Schiel's Anti-Friction Curve." See Nystrom's "Mechanical Hand-Book."

The Great Eastern Railway terminal station at Liverpool St., London, already one of the largest stations of its kind, will, it is said, be the largest terminal in England when the extensive works now being carried out are completed. These have absorbed practically a whole parish; hundreds of houses have been removed, and 130,000 cu. yds. of earth have had to be dug out. The station will cover 15 acres of ground; will have 18 platforms, 20 tracks, and be 500 ft. in width. Eight new tracks and eight platforms have been added, four of these 500 ft. and one 700 ft. long. Two incline roadways similar to those leading

down from Liverpool St. will be made to approach the station from Bishopsgate St., the station being below the street level. A spacious new parcels office is being added, and the whole station will be illuminated with electric light. There are six main tracks leading into the station, and the switch and signal interlocking plant is very complete. The station has a very busy main line and suburban traffic, and there are now between 700 and 800 incoming and outgoing trains daily, which may be increased to 1,000 trains with the new extensions. The Union Station at St. Louis, Mo., is 601 ft. wide, 700 ft. long and has 30 tracks.

The very complete and comprehensive railway exhibit of the Baltimore & Ohio R. R. Co. at the Columbian Exposition has been presented to the Field Columbian Museum, of Chicago, by President Mayer, of the B. & O. Co. In making this gift Mr. Mayer stipulates that Major J. G. Pangborn, who made the original collection, be sent abroad with power to secure additional relics of the early railway age. This stipulation has been accepted by the managers of the museum, and $25,000 has been set aside for a beginning in this work. As presented to the museum the collection consists of 56 models of locomotives and 1,700 pictures and photographs, representing a complete history of the evolution of railway transportation. The purpose of those interested is to make this the greatest railway museum in the world, and it is claimed that the active assistance of men like George M. Pullman, Cornelius Vanderbilt, Marshall Field and the presidents of the leading trunk railways in the country is already secured in this interest. It is already arranged that a commission be sent out on a two-years' collecting tour around the world. This commission will include Major Pangborn, Lieut. A. C. Baker, U. S. N.; Mr. W. H. Jackson, of Denver, Colo., as photographer; Mr. E. E. Winchell as artist, and Mr. H. F. Stevenson, as Mechanical Engineer and Secretary.

International standards for the analysis of iron and steel are to be formulated by a committee consisting of Dr. Chas. B. Dudley and Messrs. W. P. Barba, A. A. Blair, T. M. Drown and Porter W. Shimer. This committee will report to the standing international committee, made up of seven chemists from each of the five countries, England, France, Germany, Sweden and the United States. At a meeting of the sub-committee on Dec. 13 it was decided to send a circular to the iron and steel chemists of the country asking for a brief outline of the methods which they prefer and the reason for all the important points of their methods.

It was also decided that the work of the committee should comprehend the recommendation of standard methods to be used as the basis of commercial transactions, and when any of these methods could not be used in steel works in daily practice, on account of time required, an alternative rapid method should be recommended and its limitations defined.

The first method to be taken up will be the determination of phosphorus in steel.

The Western & Atlantic R. R. Co., of Georgia, leased for 29 years from Dec. 27, 1890, by the Nashville, Chattanooga & St. Louis Ry. Co., at a rental of $420,012 per annum, was built by the State of Georgia in 1841-1850 and is still owned by the state. This road connects Atlanta, Ga., with Chattanooga, Tenn., and is 137.4 miles long. The estimated value of the road and property at the date of the above lease was $6,164,575. The rental of $35,000 per month is said to pay almost one-third of the actual expenses of state government, and a late statement of its gross earnings for the last 25 years shows a remarkable evenness of income, averaging about $1,300,000 per annum. This excellent record is doubtless due to the fact that the road traverses, for the most part, a region of abundant resources in agricultural and mineral products to be transported.

The number of channeling machines on the Chicago drainage canal has been in dispute, but we find on inquiry from the makers of the two types of machines in use that there are now 17 channelers built by the Ingersoll-Sergeant Drill Co. and 25 built by the Sullivan Machinery Co. Two more Ingersoll machines will be at work soon on Section 9, making 44 in all. Of the Sullivan machines 17 are at work under subcontract.

The scheme to run trains of the Brooklyn elevated railways across the East River Bridge is making some progress. On Feb. 6 Chief Engineer O. F. Nichols, M. Am. Soc. C. E., submitted plans for a superstructure to be placed over the present carriageways to carry the elevated tracks. It is proposed to have a head house terminal on the New York end, and to run the trains across the bridge by either a cable or by electric motors. The plans have been referred to Mr. Roebling, the Chief Engineer of the bridge during its construction.

A number of improved railway cars have been built at the shops of the South Indian Ry. (meter gage) for the through mail train service. Each train consists of eleven passenger cars 40 ft. long, on four-wheel trucks, a mail car 20 ft. long and two brake cars 20 ft. long. The composite cars have a first-class compartment, with bathroom the full width of the car, two second-class compartments, with bathrooms, and one third-class compartment for passengers' servants, having doors to the first-class and one of the second-class compartments. The first-class compartment is upholstered in green leather and fitted with a table, etc. The other nine passenger cars are all third class, one of them exclusively for women. The cars have Fox pressed steel underframes and are fitted with the automatic vacuum brake.

Tests with the small caliber magazine rifle for the navy and marine corps have been lately conducted at Newport and Indian Head, for the special purpose of determining velocity and penetration of the projectile. The caliber is the .236 in. lately adopted by the Navy Department, and the 20 barrels used were made by different manufacturers, and five of them were of nickel-steel. Imported French smokeless powder was employed. At Newport the shots penetrated 42 ins. of pine, and developed a velocity of 2,300 ft. per second. At Indian Head they penetrated, at 100 yds. range, 62 ins. of superimposed 1-in. pine boards, with a velocity of 2,600 ft. per second. The bullets were partly melted in their twisting flight through the boards.

CONSTRUCTION NEWS.

(Readers are invited to contribute items concerning new construction in this issue to engineers or contractors for insertion in these columns. Those using these pages for information are informed that all concerning calls for proposals are inserted but once, and are not repeated from week to week.)

RAILWAYS.

East of Chicago—Existing Roads.

CLEVELAND, LORAIN & WHEELING.—Bids are asked until Feb. 20 for graduation, masonry and frame trestles for 28 miles of railway between Cleveland and Mallet Creek, O., as stated in our advertising columns. Ch. Engr., Wm. C. Jewett, Cleveland.

GRAND TRUNK.—The city of London, Ont., has voted to contribute $100,000 toward the erection of car shops by this company in that city.

LOUISVILLE, NEW ALBANY & CHICAGO.—About 100 men have been put at work enlarging the tunnel on the Bedford & Bloomfield road between Bedford, Ind., and Owensburg, preparatory to changing the line to standard gage. The tunnel is about three-fourths of a mile in length, and it is estimated that the work will progress about 8 ft. per day at each end of the tunnel.

WESTERN MARYLAND.—Press reports state that the contract has been awarded for extending the Baltimore & Harrisburg from the present terminus in West York to near the center of the city of York, Pa. The work will require considerable cutting and filling. The contract for the bridge over the Codorus Creek has not yet been awarded.

Projects and Surveys.

MAINE SHORE LINE.—It is stated that the construction of this railway is expected to be commenced in the spring. The line will extend from Calais to Hancock, Me., 125 miles, where a connection will be made with the Maine Central.

TORONTO & COLLINGWOOD AIR LINE.—Frank Moberly, Ch. Engr., Collingwood, Ont., writes us that the four-line reference to this project in our issue of Jan. 25 has flooded him with applications for employment of different kinds. The construction of the road is merely agitated at present, and no contracts will probably be awarded for some time.

Southern—Existing Roads.

CHESAPEAKE & OHIO.—A bill has been introduced in the legislature authorizing this company to extend its line into the city of Norfolk, Va. The company purchased property at a cost of $356,000 in the city last April.

ROARING CREEK & CHARLESTON.—This company, incorporated last spring, has the construction of its line from a connection with the West Virginia Central & Pittsburg, near Elkins, W. Va., to the property of the U. S. Coal & Mfg. Co., 30 miles down Roaring Creek, well under way. The work is being done by Matthew King, contractor, and Capt. John Potts is superintendent in charge.

Projects and Surveys.

VIRGINIA, SEABOARD & WESTERN.—A bill has been introduced in the legislature incorporating this company to build a railway from Danville or North Danville to a point on the East Tennessee, Virginia & Georgia or the Norfolk & Western near Bristol; capital stock, $100,000; C. W. Grandy, Mayer Lyman, R. B. Tunstall, W .W. Old, W. B. Hatcher, Caldwell Hardy and Edward Brockenbrough. It is stated that the construction of the road is assured.

Northwest—Projects and Surveys.

EASTERN NEBRASKA & GULF.—Incorporated in Nebraska to build a railway from Sioux City, Ia., through Nebraska, Kansas and to the Gulf of Mexico; capital stock, $1,500,000. The incorporation papers were filed by F. A. Seamans, Sioux City, Ia., an official of the Sioux City & Northern, and were signed by A. W. Swanitz, New York; F. W. Kimball, Austin, Minn.; C. J. O'Connor and Thomas Ashford, Jr., of Homer, Neb.; W. C. McNamara, F. A. Seaman and J. B. Keefe, Sioux City. Press reports state that nearly all the directors are officers of Jas. Hill's Sioux City line; that the road will be built to Omaha this year, that the line is already being surveyed, and that the contract for building the first 50 miles has been awarded to Kimball & McNamara, Sioux City, Ia.

Southwest—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—Press reports from Santa Fe, N. Mex., state as follows: Word has been received from northern Colfax county that construction work has been begun on the new railway that is to cross the mountains from Maxwell City to Amizette and Taos. This means the coming of the Rock Island across to Colfax, Taos, Rio Arriba and San Juan counties and the early resumption of work on the Rock Island's line between Liberal, Kan., and Maxwell City. The new line will touch Amizette, run five miles south of Taos, where a new Taos City will be built, thence northwest, crossing the Rio Grande at Chama and go up the Rio Chama. W. D. Cameron, New York, is said to be at the head of the new enterprise. Ch. Engr., E. H. Smith.

GULF, BEAUMONT & KANSAS CITY.—It is stated that this company has secured control of 10 or more miles of the Beaumont Lumber Co's. railway in Jasper county, Tex., extending from Ford's bluff on the Neches River to the town of Buna. Work of widening the gage will soon be commenced.

MISSOURI, KANSAS & TEXAS.—This company is reported as raising $700,000 for replacing light rails with heavier ones, for stone ballasting and for sidings.

Projects and Surveys.

CLAYTON & CREVE COEUR.—Incorporated to construct a railway from Clayton, Mo., to a connection with the Missouri Pacific at Chapman, Mo.; capital stock, $5,000; Henry Chomeau, Phil Deuser, W. H. Glensfelder, H. M. Smith and Jacob Studt.

KANSAS, OKLAHOMA & TEXAS.—Incorporated in Kansas to build a railway from Arkansas City, Kan., to Eagle Pass, Tex., 950 miles; capital stock, $10,000,000; W. S. Nelson, H. A. Younge, W. H. Campbell and W. C. Huckett, Kansas City; Charles French, Chicago; A. J. Hoskinson, Garden City, Kan.; Albert Carroll, New York.

Rocky Mt. and Pacific—Projects and Surveys.

ARIZONA.—A press report from Prescott, Ariz., states that W. A. Clark, Butte, Mont., owner of the United Verde Copper Co.'s mines at Jerome, in this county, has placed a corps of engineers in the field to survey a line for a narrow-gage road from a point on the Santa Fe, Prescott & Phoenix to his mines, a distance of 28 miles. He expects to complete the road during the present year.

MONTEREY & FRESNO.—At a meeting at Fresno, Cal., Jan. 24, it was stated that the right of way through that county, and a bonus of $1,000 a mile had been guaranteed for this proposed railway. Bonds to the amount of $2,000,000 are now in the hands of the engraver and it is confidently expected that the construction of the road will be commenced at Monterey this month. Pres., A. W. Jones, Kansas City, Mo.; Ch. Engr., P. P. Dandridge, Monterey, Cal.; Gen. Man., H. A. Greene, Monterey, Cal.

Foreign.

TEHUANTEPEC.—A press report from the city of Mexico states that Chandos Stanhope has 1,200 men at work on this railway, and will give place for 600 more within a fortnight. Work is being pushed from 14 large camps, and it is expected the new road will be in operation by next September. The completion of the Tehuantepec line will mark the opening of the first transcontinental line in Mexico.

STREET AND ELECTRIC RAILWAYS.

CONWAY, MASS.—Sydney G. Walker, who has been engaged for some time in investigating the feasibility of constructing a dam in South River, is stated to have reported that 300 or more horse power could be generated there for an electric railway to Conway station. It is proposed to construct a standard gage road for both freight and passenger traffic.

HOLYOKE, MASS.—The People's Electric Ry. Co. has filed articles of incorporation; capital stock, $100,000; Wm. F. Whiting, Jas. E. Delaney and Chas. H. Curran are among those interested, all being residents of this city. If the desired franchise is granted it is expected that the construction of the road will be commenced as soon as the weather will permit.

NATICK, MASS.—J. C. Lane and others have petitioned for a charter for the Natick, Newton & Boston St. Ry. Co., with a capital of $350,000, the road to operate in Natick, Framingham, Needham, Wayland, Marlboro, Newton, Watertown and Boston, with authority to purchase certain existing franchises of E. M. Fowle and others.

NORTHAMPTON, MASS.—Authority has been granted to extend the electric railway to Williamsburg and Easthampton. W. W. Strong, Engr.

SPRINGFIELD, MASS.—The Wymanlea Electric Ry. Co. has been organized to build an electric railway from this city to Holyoke, 12 miles; capital stock, all taken, $300,000; Pres., H. B. Dickinson, Springfield; Clk., A. L. Green, and Treas., C. F. Smith, Holyoke.

NEW HAVEN, CONN.—The directors of the Winchester Ave. R. R. Co. have voted to extend the road out Congress Ave. to West River bridge, and to spend $10,000 in erecting new buildings in Railroad Grove, West Haven.

CORNING, N. Y.—F. D. Kingsbury is reported to have purchased the franchise granted about a year ago for an electric railway in this place and to be organizing a company of local capitalists to build the road.

BRADDOCK, PA.—The Braddock Electric St. Ry. Co. will rebuild its old line and has given a bond to have the work completed by July 1. Pres., A. L. Taylor; Secy., C. F. Ellis.

PHILADELPHIA, PA.—The Delaware Front Passenger Ry. Co. has been incorporated; capital stock, $24,000; Pres., Wm. Green.

CLEVELAND, O.—The Broadway & Newburg R. R. Co. has purchased 100 Westinghouse motors, according to reports, and is planning other improvements.

COLUMBUS, O.—The Indianola Fourth St. Ry. Co. has been incorporated by Chas. E. Miles, Robt. Thompson, J. J. Dun and others; capital stock, $10,000.

TOLEDO, O.—Josiah D. Cook has completed surveys for the Maumee Valley Electric Ry., projected between this city and Perrysburg. Pres., Wm. B. Taylor.

BATTLE CREEK, MICH.—It is stated that the street railway will be rebuilt, at a cost of $80,000.

FREEPORT, ILL.—A syndicate of capitalists has purchased the horse car line and contracted with C. E. Loss, Pullman B.dg., Chicago, for constructing a new brick power station and remodeling the system into an electric line. Two 150-HP. generators and duplicate steel tubular boilers will be used and six miles of track will be laid.

MADISON, WIS.—It is stated that the electric railway will be extended to Wingra Park this coming summer.

MINNEAPOLIS, MINN.—M. B. Ridgeway, of this city, is agitating the construction of an electric railway between this city, St. Paul and Superior and Duluth, the motive force to be derived from the water powers along the proposed route.

ELEVATED RAILWAYS.

BROOKLYN, N. Y.—The Brook'yn Elevated R. R. Co. is said to be considering the advisability of extending its Fifth Ave. line through Bay Ridge to Fort Hamilton, at an estimated cost of $300,000 to $400,000 per mile.

CHICAGO, ILL.—The Chicago North Division Elevated R. R. Co. has been incorporated by Marcus Pollasky, L. O. Goddard, Wm. Sooy Smith, F. W. Gardner and J. T. Hall, Chicago, and W. W. Tracey, Springfield; capital stock, $10,000,000.——The Metropolitan Elevated Ry. Co. is reported as expecting to have its road in full operation by May 1. Contracts have been awarded for locomotives and cars to be completed before that date.

HIGHWAYS.

PENNSYLVANIA.—Bids are asked until Feb. 10 for constructing a boulevard from Scranton to Elmhurst, Lackawanna county. Ch. Engr., Chas. C. Mattes, Scranton.

OHIO.—Bids are asked by the commissioners of Hamilton county, Cincinnati, until Feb. 14 for the sale of $76,000 of 4% bonds for improving Columbia Ave., in Columbia township.——Bids are asked until Feb. 28 for the purchase of $75,000 of 5% turnpike improvement bonds. W. D. Corn, auditor of Lawrence county, Ironton.——F. Krug, Engr. Hamilton county, has been instructed to prepare plans for improving Carthage road; total estimate, $348,494, including 98,000 sq. yds. brick paving, 18,000 cu. yds. concrete and 100,000 cu. yds. grading.

INDIANA.—The citizens of Adams township, Hamilton county, are reported as about to petition the county commissioners for a special election to vote a 2% tax to be used in improving the principal roads of the township.

MINNESOTA.—Residents of Crookston are urging the construction of a wagon road from that city, in Polk county, to the Rainy Lake gold country and to Tower, in St. Louis county. It is suggested that the government should assist in the undertaking.

MISSOURI.—Bids will be asked for grading and macadamizing Blue Ave. between Kansas City and Independence, and for improving Jackson Ave. Isaac Jackson has been appointed supervisor of the latter work. F. J. O'Flaherty, Co. Surv., Independence.

COLORADO.—The legislature has passed a bill appropriating $15,000 for a wagon road in Hinsdale county and $15,000 for a road from Leadville to Mt. Sherman.

WASHINGTON.—Press reports state that the citizens of Wenatchee, Chelan and the Okanogan country are making a united effort to get a wagon road opened from the north down the Columbia River to Wenatchee. Money and labor are being subscribed to open the road, and petitions asking for a continuous mail route from Ruby City and Conconully are receiving hundreds of signatures. This is said to be the only practical outlet for the Okanogan country, as the Columbia Valley is free from snow blockades in winter.

BRIDGES AND TUNNELS.

BOSTON, MASS.—The park commissioners will receive bids until Feb. 19 for the construction of a stone bridge on the parkway over Leverett Pond.

NEW YORK, N. Y.—The itemized bids for the Ogden Ave. viaduct approach to the Seventh Ave. swing br.dge were published last week under Contract Prices. We are informed that the approach consists of six plate-girder spans, 55 ft. each, supported by an abutment, by nine columns on pile foundations and by one masonry twin pier on pneumatic foundations. There will be a 40-ft. roadway and two 9-ft. sidewalks, with an asphalt pavement on a buckle-plate floor. The viaduct as a mean elevation of 28 ft. The superstructure is to be open-hearth steel, mostly reamed work. Consult. Engr., Alfred P. Boller.

NEW YORK, N. Y.—W. Katte, Ch. Engr. N. Y. C. & H. R. R. R., informs us that bids were received Jan. 19 for the north approach spans of the bridge across the Harlem River. There will be a 185½ ft. span, estimated weight 850 tons, and a 131⅝ ft. span, estimated weight 480 tons. The bridge will have three through-pin connection trusses, a solid floor system and four railway tracks. The bids were as follows: Phoenix Bridge Co., $157,380; Shiffler Bridge Wks., $117,000; Youngstown Bridge Co., $112,910; Cofrode & Saylor, $107,800; New Jersey Steel & Iron Co., $98,-715; Pennsylvania Steel Co., $93,000; Pencoyd Bridge Co., $86,604; Elmira Bridge Co., $85,840; Union Bridge Co., $84,569; King Bridge Co., $84,000.

WARREN, PA.—It is reported that contracts will soon be awarded for four new steel bridges on the Dunkirk, Allegheny Valley & Pittsburg R. R.

CINCINNATI, O.—Plans will soon be made for a $70,000 bridge over Milk Creek on Spring Grove Ave.

CLEVELAND, O.—A new bridge will soon be constructed by the county over Nine-Mile Creek, east of the city, according to reports.

CHICAGO, ILL.—The following bids were received Jan. 26 for the superstructure for the Van Buren St. bridge: Binder Seifert, $74,150; King Bridge Co., $73,000; Chicago Bridge & Iron Co., $79,994; C. L. Strobel, $80,900; Shaffer & Schinglau, $64,840; N. J. Steel & Iron Co., $75,188; American Bridge & Iron Wks., $85,000; Milwaukee Bridge & Iron Co., $69,488; Mt. Vernon Bridge Wks., $68,750; A. Gottlieb, $59,700; Detroit Bridge & Iron Co., $65,000; Pittsburg Bridge Co., $65,900. The contract was awarded to A. Gottlieb, Chicago, as stated last week.——The estimates for this year include $228,176 for new bridges and $146,600 for bridge and viaduct repairs.

DES MOINES, IA.—Plans are about completed for the Ninth St. viaduct and the commissioners have already ordered its construction.

HELENA, MONT.—Bids are asked until Feb. 19 for the construction of an iron or steel bridge over the north fork of Sun River about five miles from Augusta; length of main space, 200 ft.; to be built on iron tubular piers 16 ft. long; cost not to exceed $8,000. Address commissioners of Lewis, Clarke and Teton counties.

FLORENCE, COLO.—The county commissioners have authorized the building of a new county bridge over the Arkansas River at this place, according to reports. The structure will be of iron, about 250 ft. long, and will cost about $10,000.

WATER-WORKS.

HAMILTON, N. H.—It is reported that Boston parties are contemplating putting in works here.

NEWPORT, N. H.—It is estimated that works could be put in for $46,227 or $56,552, according to source of supply.

PETERBORO, N. H.—The committee appointed nearly a year ago to investigate the question are reported as about ready to receive estimates on the cost of constructing works; supply from Cunningham Pond.

MANCHESTER, VT.—There is talk of securing a supply from Mount Equinox.——A meeting was held Feb. 5 to consider the question of a supply and better fire protection.

GREENFIELD, MASS.—Jas. Porter, Supt., writes us that a reservoir will probably be constructed, but the details have not been decided upon and a vote of the district must first be taken.

QUINCY, MASS.—The city will spend $60,000 for extensions and improvements.

READING, MASS.—Lewis M. Bancroft, Supt., writes us that Frank L. Fulton, Boston, is preparing plans for a covered settling reservoir, also for a filter plant.

SHARON, MASS.—The town wishes authority to issue $50,000 of bonds to purchase the works of the Sharon Water Co., according to reports.

SHEFFIELD, MASS.—T. C. Wickwire writes us that surveys have been made and some preliminary work done, but that no definite plans have been made; the present need being funds to carry on the work.

SOUTHBRIDGE, MASS.—The Southbridge Water Supply Co. has petitioned for authority to take Hatchet Brook as an additional supply, and to increase its capital stock to $100,000.

WALPOLE, MASS.—A meeting will probably be held soon to see if the town will accept the act giving it the right to secure municipal works.

WEST BOYLSTON, MASS.—The citizens are reported as investigating the question of works.

WATERBURY, CONN.—Bids are asked until Feb. 16 for constructing sections 1 and 2, six miles, of the 36-in. cast iron pipe conduit; R. A. Cairns, Engr.—— The bids for section 3 were as follows, but were all rejected as too high: Martin Lipps, New York, $38,077; John W. Gaffney & Co., Waterbury, $44,135; Continental Const. Co., New York, $42,948; H. S. Tuttle, Swampscott, Mass., $51,496; C. H. Eglee, Flushing, N. Y., and E. E. Eglee, New York City, $60,488; Patrick Thompson and W. H. Knibbs, Waterbury, $37,-671; Edward McManus, Waterbury, $40,991.

ALBANY, N. Y.—Bids are asked until Feb. 13 for 450 tons of 20 to 3-in. pipe and 15 tons of special castings, price to be per ton of 2,240 lbs. delivered f. o. b. cars in this city. Geo. I. Bailey, Supt.

BUFFALO, N. Y.—Bids are asked until Feb. 21 for valves, hydrants, etc., during 1894. J. E. Ransom, Secy. Dept. Pub. Wks.

COXSACKIE, N. Y.—Surveys are being made for works.

FREDONIA, N. Y.—The question of filtering the supply is being discussed.

FREEPORT, N. Y.—We are informed that bids will be asked about Feb. 15 for works. Engr., C. A. Lockwood, Jamaica.

NIAGARA FALLS, N. Y.—The citizens have voted in favor of issuing $50,000 of bonds for extensions.

PENN YAN, N. Y.—Edson Porter is chairman of a committee appointed to investigate the question of new works.

SYRACUSE, N. Y.—Bids are asked until Feb. 16 for trenching, pipelaying, etc. J. B. Brooks, Secy. Bd.

TROY, N. Y.—The commissioners contemplate laying about 7,000 ft. of pipe, at an estimated cost of $40,000.

WEST TROY, N. Y.—Press reports state that $11,859 has been appropriated for improving the supply at Watervliet arsenal.

ALLEGHENY, PA.—The committee has decided to have plans prepared for laying a steel conduit to Nine-Mile Island and the erection of a pumping station at that point. This resolution takes the place of the one passed some time ago which favored asking for bids according to three plans.

BEAVER FALLS, PA.—W. W. Kerr, Secy. council, writes us that an election will be held Feb. 20 to vote on the proposed loan of $125,000 for works, noted Jan. 25.

ALTOONA, PA.—The question of increasing the supply is expected to be considered at the coming election.

CONFLUENCE, PA.—The citzens are reported as considering the question of works and electric lights.

GIRARDVILLE, PA.—The taxpayers are considering the selling of the works.

HARRISBURG, PA.—Geo. G. Kennedy, Secy., writes us that the council voted against the purchase of additional pumps, and that nothing definite has been done in the matter of filtration and probably will not be for some time.

MEADVILLE, PA.—W. R. Vance, Cy. Clk., writes us that the city solicitor has been instructed to prepare an ordinance declaring that the city shall own its own works. The city may purchase the works, otherwise new works may be put in.

PHILADELPHIA, PA.—The department of public works has been directed to make extensions in about 25 streets.

QUARRYVILLE, PA.—The Quarryville Water Co. has been incorporated with a capital stock of $10,000; Treas., A. S. Harkness.

SCRANTON, PA.—The South Abington Water Co. has been incorporated to operate in South Abington township, Lackawanna county; capital stock, $2,500; Treas., J. A. Davis.

BOONSBORO, MD.—It is proposed to secure a supply from the mountains; estimated cost, $10,000.

POCOMOKE CITY, MD.—Reports state that the question of works is being discussed.

SNOW HILL, MD.—We are informed that the legislature will probably be petitioned for authority to issue $18,000 of bonds for works and other improvements.

PETERSBURG, VA.—The council has voted to issue $80,000 of 40-year 5% water and improvement bonds.

WHEELING, W. VA.—G. M. Varney, Supt., writes us that the formal inspection of the new works took place Jan. 25 and that everything is working satisfactorily.

AIKEN, S. C.—An election will be held Feb. 19 to vote on an issue of bonds for works.

GREENWOOD, S. C.—R. M. Freeman is reported as wishing to correspond with water-works contractors.

MADISON, FLA.—C. B. Ashley, Clk., writes us that plans are being prepared for works, for which it is proposed to issue bonds for $16,000; supply from non-flowing artesian well; contracts probably awarded in April or May; population, 1,200.

TROY, ALA.—It is expected that the construction of the proposed works will be commenced at once.

BROWNSVILLE, TENN.—A proposition for works is being considered, according to reports.

ELIZABETHTON, KY.—It is stated that works will be put in.

ELKTON, KY.—The citizens are reported as considering the question of a system.

RUSSELLVILLE, KY.—Works will probably be put in at an early date.

CADIZ, O.—W. H. Lucas, Tn. Clk., informs us that the capacity of the wells is being tested and that if everything is satisfactory the question of works will be taken up again.

CINCINNATI, O.—The board of administration will receive bids until March 3 for excavating and constructing masonry foundation for tank house on Price Hill.——The city auditor has been directed to sell $100,000 of water extension bonds.

DAYTON, O.—The trustees will spend at once the balance of $37,000 for extensions and authority has been secured to issue $100,000 of bonds for water works improvements.

JEROMESVILLE, O.—M. S. Hosler, Clk., writes us that works will probably be put in this summer, and that the election to vote on the question will be held Feb. 14.

KENTON, O.—Press reports state that the reservoir will be enlarged to give work to the unemployed.

ORRVILLE, O.—Press reports state that $20,000 of bonds have been sold for building works.

STEUBENVILLE, O.—An election will be held in April to vote on the question of new works, recently noted.

ZANESVILLE, O.—It is reported that $25,000 of bonds will soon be sold for the stand-pipe and extensions.

ANGOLA, IND.—The citizens are considering the question of works.

DELPHI, IND.—The city will lay 2½ miles of 8-in. pipe this spring, according to reports.

GARRETT, IND.—Works may be put in, according to reports.

GOSHEN, IND.—A press report states that the city's works, under the name of the Goshen Mechanical & Mfg. Co., were sold at receivers' sale Feb. 3 to C. and E. Hawks for $16,050; sale was to satisfy a judgment of $54,000.

GREENFIELD, IND.—Harry Strickland, Cy. Clk., writes us that bids will be opened March 21 for works, including six miles of mains; supply from wells; population, 4,500; Engrs., Voorhees & Witmer, Buffalo, N. Y.

KNIGHTSTOWN, IND.—Edgar H. Cole, Clk., writes us that bids will soon be asked for works, including stand-pipe; supply from wells; population, 2,500.

LAFAYETTE, IND.—The water-works company of West Lafayette is reported as about to sell $30,000 of bonds.

BAY CITY, MICH.—The council is considering the question of improving the supply. It is proposed to unite with West Bay City and extend an inlet into the lake; also to sink a well.

GRAND RAPIDS, MICH.—Bids are asked until Feb. 17 for a 15,000,000-gallon, compound condensing, high-duty pumping engine. Fred A. Twamley, Secy. Bd. Pub. Wks.

MARCELLUS, MICH.—An election will be held March 12 to vote on an issue of bonds for $8,000 for works.

SAGINAW, MICH.—W. R. Coats, Kalamazoo, has recommended that a well be sunk.

SOUTH LYONS, MICH.—The citizens are discussing the question of works, according to reports.

BARRY, ILL.—John Wassell, Engr. Wks., writes us that nothing definite has been decided upon as regards awarding contracts for proposed extensions. Work will include a pump to lift supply from well 2,500 ft. deep to a 15 × 30 ft. stand-pipe.

EAST ST. LOUIS, ILL.—The City Water Co. is reported as about to extend its mains in the east side suburbs.

FARMINGTON, ILL.—Bids have been asked for sinking a well, 4 × 6 ft., and if a sufficient supply is secured works will probably be put in at an early date.

MADISON, ILL.—Press reports state that this place expects to have works by July 1.

PULLMAN, ILL.—A temporary contract has been made for a supply from Chicago, at 10 cts. for each 1,000 gallons up to 165,000 gallons, 8 cts. to 5,000,000 gallons, and 6½ cts. above that. The contract which expired Jan. 20 was at 4 cts. per 1,000 gallons, and it is claimed that the Pullman Assn. has been making a profit of 350% on water supplied to private consumers.

RUSHVILLE, ILL.—The citizens have voted to issue $20,000 of bonds for works.

STANFORD, ILL.—The question of works will be voted upon at the April election, according to reports.

WENONA, ILL.—It is stated that works will soon be put in.

WHEATON, ILL.—The mayor writes us that specifications for works are not yet completed, but that a complete system will be put in, including stand-pipe; supply from wells; population, 3,000.

KENOSHA, WIS.—Robt. M. Holderness, Cy. Clk., writes us that W. S. Reed, Chicago, has been engaged to prepare plans for works; supply from Lake Michigan; population, 8,000.

ALTA, IA.—It is reported that works will be put in as soon as possible.

CLEAR LAKE, IA.—The question of works will probably be voted upon next month.

EAGLE GROVE, IA.—The city is reported as contemplating securing works.

SHELDON, IA.—The city wishes to grant a franchise for works, according to reports.

TRAER, IA.—An election will be held next month at which it is expected that the question of works will be voted upon; plans include stand-pipe.

WESLEY, IA.—J. S. Gallaghors, Cy. Recorder, writes us that the city is talking of contracting for works in the near future; population, 900.

WINTERSET, IA.—Reports state that the construction of works is being discussed.

CALEDONIA, MINN.—The election Jan. 20, noted last week, resulted in a vote of 141 for works and 5 against. The plans include a well, stand-pipe, pump, etc.

WASECA, MINN.—Bids are asked until Feb. 20 for about 222 tons of 12 to 4-in. pipe, 33 fire hydrants, 1,000,000-gallon compound duplex pump, compound electric light engine, steel water tower with 20 × 30-ft. wooden tank, 20 × 35-ft. steel reservoir, pipe laying, etc. Consult. Engr., C. F. Loweth, St. Paul. Dr. D. S. Cummings, Mayor.

CONCORDIA, KAN.—It is reported that more wells will be sunk to secure an increased supply.

GARDEN CITY, KAN.—An increased supply will be secured from wells, according to reports.

AUBURN, NEB.—The citizens have voted in favor of the proposed issue of bonds for $20,000 for works.

RAPID CITY, S. DAK.—The Rapid Valley Water Co. has been incorporated; capital stock, $15,000; Francis M. Murphy, F. M. Morris, F. J. Lewis, S. J. Morris, J. P. East. Present works were built in 1885 by the city.

BUTTE CITY, MONT.—The report of the superintendent of the Butte City Water Co. shows that $90,000 was expended last year and estimates an expenditure of $100,000 this coming season. The dam will be 120 ft. high and will not be completed for about two years. The company has already spent about $1 30),0 0 and expects to float $200,000 of bonds to complete the work.

BOLIVAR, MO.—Chas. F. Sturtevant, Consult. Engr., St. Louis, informs us that the contract for works has been awarded to Geo. W. Dodley, St. Louis, at $11,267, the other bids for the entire work being as follows: Fairbanks, Morse & Co., Chicago, $13,149; Consolidated Engineering Co., St. Louis, $18,980; O. J. Gorman & Co., Dallas, Tex., $11,524; E. A. Rodiger, Nebraska City, Neb., $11,975; J. R. Truesdale, St. Louis, $13,290; Blanchard & Gosney, Springfield, Mo., $12,324. Bids for cast iron pipe will be published next week.

BRUNSWICK, MO.—J. Knappenberger, Clk., writes us that the city has voted, 4 to 1, in favor of works and electric lights, but that no plans have yet been prepared.

INDEPENDENCE, MO.—The council is considering an ordinance extending the franchise of the water company 10 years from 1904. The company offers to make important extensions and to give the city 20 additional fire hydrants, and the city is to have the right to purchase the works after 10 years.

HEWITT, TEX.—J. A. Warren writes us that no plans have yet been prepared for works.

WEATHERFORD, TEX.—The contract for a supply expired Jan. 31 and the council is considering the question of a new contract.

HIGHLAND, COLO.—At a recent mass meeting it was voted to favor granting a franchise to the Citizens' Water Co., Denver, the company to charge $30 per year for each fire hydrant and the rate for domestic purposes to be 20% lesss than at present.

SOUTH DENVER, COLO.—The council has leased the works to the American Water-Works Co. for 10 years, and has contracted with the company for a supply at a cost not to exceed 5 cts. per 1,000 gallons.

NEW WHATCOM, WASH.—The council has ordered that 6,000 ft. of 24-in. wooden pipe be laid between the intake and the reservoir. It will cost about $16,000 and is expected to last 50 years, according to reports.

PORT TOWNSEND, WASH.—It is reported that a contract will be awarded this month for works to cost $10,000 at the government quarantine station.

SEATTLE, WASH.—R. H. Calligan, Supt., has recommended the purchase of a 7,500,000-gallon and a 2,500,000-gallon pump and the construction of two 100,000-gallon tanks.

TULARE, CAL.—The Tulare Water Co. is reported as contemplating improvements with a view to securing a better supply. Pres., W. P. Ratliff; Secy., S. A. Blythe.

WINNIPEG, MAN.—The council has voted to construct four 15,000 and two 30,000-gallon tanks for fire protection.—The council is considering the question of works to be owned by the city.

BERWICK, N. S.—Bids are being received for constructing works, according to reports.

CANNING, N. S.—A bill has been introduced in the legislature relating to a supply for this place.

LUNENBURG, N. S.—A bill has been introduced in the legislature to incorporate the Lunenburg Water, Electric Light, Heating & Power Co., limited.

ARTESIAN WELLS.

MEXIA, TEX.—Money is being raised by subscription, according to press reports, for boring an artesian well.

IRRIGATION.

LEXINGTON, NEB.—Steps have been taken to organize a company to take the place of the Meridian Canal Co., which collapsed two years ago, to construct an irrigation ditch through the Platte Valley, from Kearney to North Platte.

SAN ANTONIO, TEX.—Press reports state that a company is being organized to construct an irrigation ditch 30 miles long in Uvalde and adjoining counties, the water to be taken from the Nueces River.

DENVER, COLO.—The contract for constructing the Saguache reservoir has been awarded to W. E. Dodge, Leadville, at $27,250. The bids were published Jan. 25.

COLORADO.—It is stated that $200,000 of bonds have been sold for the construction of the Bijou canal and reservoir and that the work will be commenced April 1.

SOUTH RIVERSIDE, CAL.—The South Riverside Land & Water Co. has advertised for bids for the construction of a dam at Lee Lake.

PHOENIX, ARIZ.—F. C. Kendrick, Denver, Colo., has been at work for two months surveying for the proposed reservoir and canal of the Pennsylvania Irrigation Co. north of this city. Col. Willis D. Huling, Pres., Oil City, Pa., is reported as stating that the construction will be commenced as soon as the wet season is over, which will be in about six weeks.

NEW COMPANIES.—Middle Loup Valley Irrigation Co., Sargent, Neb.; $50,000; plans being prepared for irrigating 50,000 acres; Pres., E. P. Savage; Secy., J. E. McCray.——Grand Valley Irrigation Co., Grand Junction, Colo.; $240,000; Pres., B. C. Oyler; Secy., A. J. McCune.——Brown Irrigation & Land Co., Austin, Tex.; $100,000.—Forfar Lateral Irrigation Ditch Co., Denver, Colo.; to build and operate a lateral canal from the Larimer and Weland canal; D. H. Gale, E. K. Packard, F. G. Reeman, Bruce Eaton, R. D. Campbell.

SEWERS.

BEVERLY, MASS.—The town has instructed the selectmen to proceed at once to issue bonds and to commence the construction of sewers without delay.

EVERETT, MASS.—Bids are asked by the sewer commissioners until Feb. 17 for 20,000 ft. of Akron sewer pipe.

HUDSON, MASS.—Plans are being considered for sewage disposal other than by emptying it into the Assabet River, according to reports.

LEICESTER, MASS.—Plans for a system have been prepared; estimated cost of 8,410 ft. of 8 to 10-in. pipe sewers, $8,410, and of sewage disposal works, $2,674.

MARLBORO, MASS.—The legislature will be petitioned for authority to issue additional sewer bonds.

WINCHESTER, MASS.—The town has voted to petition for authority to issue $100,000 of bonds for a system.

BRISTOL, CONN.—R. S. Newell informs us that plans are being made for sewers and for disposal works and that it is hoped to award contracts for the construction next summer. Engr., T. H. McKenzie, Southington.

BUFFALO, N. Y.—Bids are asked until Feb. 21 for constructing 20 to 12-in. tile sewers. J. B. Ransom, Secy. Dept. Pub. Wks.

NEW YORK, N. Y.—The commissioner of street improvements in wards 23 and 24 will receive bids until Feb. 20 for two sewers.

EAST ORANGE, N. J.—Jas. Owen, Engr., Newark, writes us that the following bids were received for the outlet sewer: Thos. J. Regan, $260,000; Lee & Minihan, Orange, $250,000, and Thos. Nevins & Sons, Orange, $230,000.

MEADVILLE, PA.—Bids are asked until Feb. 21 for constructing a sewer in East Chestnut St. W. R. Vance, Cy. Clk.

MONTGOMERY, ALA.—Bonds for $100,000 have been sold for repairing and constructing sewers.

LEXINGTON, KY.—Plans for a complete system have been prepared by Col. Geo. E. Waring; estimated cost, including 40 acres of land for sewage disposal, $119,680.

CANTON, O.—Authority has been asked to build a 6½-ft. brick sewer one mile long. About four miles of other work is also reported as under consideration.

CINCINNATI, O.—Bids are asked by the board of administration until Feb. 27 for the extension of the trunk sewer in Boldface Creek.——Plans have been prepared for constructing sewers in six streets.

DAYTON, O.—The board of city affairs will expend $22,000 for sewers.

NELSONVILLE, O.—L. E. Chapin, Cy. Engr., Canton, is preparing plans for a system.

YOUNGSTOWN, O.—Plans are being prepared for several sewers, and it is stated that the construction will be commenced early in the spring.

INDIANAPOLIS, IND.—The board of public works has voted to construct a main sewer 12,578 ft. long and a local sewer 2,245 ft. long.

EVANSVILLE, IND.—Bids are asked by the board of public works until Feb. 17 for three local sewers.

LOGANSPORT, IND.—The council has voted to extend the sewers 2,000 ft. and to make other improvements to give employment to men out of work.

PANA, ILL.—It is reported that a system to cost $50,000 is to be constructed after the water-works have been completed.

MILWAUKEE, WIS.—The contract for a sewage disposal plant to purify 300,000 gallons of sewage daily at the county buildings at Wauwatesa has been awarded to W. F. Goodhue and H. Schlenstedt, at $22,500, according to reports. O. E. Meyers bid $19,000 and Wm. Forrestal $10,000, but it was estimated that the annual expense of operating Mr. Goodhue's plant would be only $750 to $1,000 against $2,000 to $2,500 for the plants of Mr. Meyers. Mr. Forrestal's bid was not according to specifications.

MUSCATINE, IA.—The committee has engaged G. T. Baker, Davenport, as consulting engineer of proposed system for which plans are being made by the city engineer.

RED WING, MINN.—It is reported that the system will be extended this season.

JAMESTOWN, N. DAK.—Bids are asked until March 6 for constructing 4,113 lin. ft. of 12 to 8-in. pipe sewers. Consult. Engr., C. F. Loweth, St. Paul; Alfred Steel, Mayor.

BRANTFORD, ONT.—Bids are asked until April 2 for the sale of $60,000 of 4% sewer bonds. J. Woodyatt, Clk.

STREETS.

BUFFALO, N. Y.—Bids are asked by the board of public works until Feb. 21 for repairing stone and asphalt pavements.

NEW YORK, N. Y.—The commissioner of street improvement in wards 23 and 24 will receive bids until Feb. 20 for paving in one street with granite blocks.

BRADDOCK, PA.—The Braddock St. Ry. Co. will rebuild its line and macadamize the township streets.

EASTON, PA.—Bids are asked in our advertising columns for crushed stone. The bids recently rejected for this work were published Jan. 25. H. R. Febr, Cy. Engr.

ATLANTA, GA.—The bids for constructing sidewalks have been rejected and the work will be readvertised.——The council is considering the advisability of paving with vitrified brick. It is stated that brick paving would cost $2 per sq. yd., against $1.50 for Belgian blocks and $3 for asphalt.

MONTGOMERY, ALA.—Bonds for $125,000 have been sold for street improvements.

NEW ORLEANS, LA.—Bids will be asked for paving several streets with brick.

LEBANON, TENN.—The board of commissioners have ordered new brick pavements for the entire town, according to reports.

LEXINGTON, KY.—The city engineer has prepared plans for paving East Main St. with brick; estimated cost, $62,288.

AKRON, O.—Bids are asked until Feb. 27 for about three miles of paving with brick; estimated cost, $120,000. E. A. Hersley, Cy. Clk.

DAYTON, O.—The city comptroller has been authorized to advertise the sale of $200,000 of improvement bonds, including $50,000 each for streets and sewers.

INDIANAPOLIS, IND.—The board of public works has voted to pave two streets with asphalt.

BAY CITY, MICH.—Several streets are to be repaved.

ST. JOSEPH, MICH.—The citizens have voted to issue bonds for $30,000 for street improvements.

SAGINAW, MICH.—The council has voted to pave 11 streets at an estimated cost of $166,000.

CHICAGO, ILL.—The city estimates for this year contemplate an expenditure of over $16,000,000 and include $300,000 each for improved and unimproved streets and $100,000 for sidewalks.

ST. LOUIS, MO.—The board of public improvements will reconstruct 12th St. with asphalt at an estimated cost of $52,000.——Ordinances have been passed for paving several streets with brick.

ELECTRIC LIGHT AND POWER.

HIGHLAND FALLS, N. Y.—W. C. Anthony, Newburg, Lewis F. Goodsell, supervisor of town of Highland, and Capt. C. F. Roe, New York, have organized a company to put in an electric light plant in this place, according to reports.

LOCKPORT, N. Y.—The contract for electric street lighting has been awarded to the Lockport Gas Light Co., at $72 per year for each arc light, the contract to be canceled upon 30 days' notice whenever the city erects a plant of its own. Chas. H. Cornes, Cy. Engr.

SPRINGVILLE, N. Y.—The Springville Water-Works Co. has been granted a franchise for an electric light plant.

ANNAPOLIS, MD.—Bids are asked until Feb. 12 for lighting the city with electricity or gas for three or five years. Thos. Himelheber, Cy. Clk.——It is reported that the council has made an appropriation for plans for a municipal plant.

CLEVELAND, O.—The council is considering a bill authorizing the city to issue $750,000 of bonds for a municipal electric light plant.

DETROIT, MICH.—The lowest bids for the equipment of the city's electric light plant aggregate about $124,000, and were as follows: Engines, Samuel F. Hodge & Co., $20,000, triple expansion; $17,000, compound; water tube boilers, Link Belt Machinery Co., Chicago, standard, with Hawley down-draft furnace, $32,650; shell boiler adapted for high-pressure, C. A. Stredinger & Co., Detroit, Peck boiler, with Hawley furnace, $31,500; dynamos, direct line of specifications, Western Electric Co., Chicago, $41,250; lamps, double-carbon, Brush Electric Co., Cleveland, $41,900; single-carbon, Peninsular Electric & Engineering Co., Detroit, Kester lamp, made in Buffalo, $29,775; dynamos and lamps and engines alternating system, Westinghouse, Church & Co., New York, $89,385. The lowest bid for the construction of the station were published last week.

GRAND RAPIDS, MICH.—It is reported probable that an election will soon be held to vote on an issue of $150,000 of bonds for a municipal electric light plant.

CEDAR RAPIDS, IA.—Bids are asked until Feb. 12 for 100 or more 2,000-c. p. arc lights for five years. J. L. Hardwick, Chn. Bd. Pub. Wks.

NEW COMPANIES.—Hazlewood Electric Co., Pittsburg, Pa.; $20,000; Treas., F. C. Kohne.——Crescent Electric Co., Scranton, Pa.; $50,000; Treas., Thos. E. Jones, Dunmore, Pa.——Chicago Electric Trunk Co., Chicago, Ill.; $25,000; C. W. Lyman, John Fraser, G. V. Graham.——Superior Light, Heat & Power Co., Chicago, Ill.; $50,000; F. L. Goulding, L. J. Mosness, A. F. Wright.——Electric Storage & Equipment Co., Chicago, Ill.; $25,000; E. W. Applegate, O. R. Stratton, Bartlett Lindley.

CONTRACT PRICES.

SEWAGE PUMPING PLANT.—Reading Pa.—The following bids were received by S. S. Hoff, Cy. Engr., Jan. 29, for the erection of a sewage pumping plant complete, of 5,000,000 gallons capacity in 24 hours, with plans and estimates for a sewage disposal and purifying plant, each bidder submitting his own plans and specifications subject to certain general conditions; item 1 includes a sewage well, etc., and buildings for 15,000,000 gallons pumping capacity, and item 3 includes land for 10,000,000 gallons capacity:

Bids for Erecting a Sewage Pumping Plant, Including Estimate for Disposal Plant, Complete, Reading, Pa.

Bidders.	5,000,000-gall. pumping plant, complete.	Additional 5,000,000 gall. pump.	Disposal plant for 5,000,000 galls.		Totals.		Remarks.
			With land.	Without land.	With land.	Without land.	
A. J. L. Loretz, Brooklyn	$82,750	$25,000	$215,000	.....	$322,750	.....	Combined chemical precipitation with artificial filtration.
Wm. P. Dallett, Philadelphia, J. J. Powers, New York	36,250	8,700	.....	$124,000	.....	$168,950	Chemical precipitation.
Pennsylvania Sanitary Sewage Co., Philadelphia	59,250	10,100	81,500	.....	150,850	Different locations	Elevated filter beds—no chemicals—"West system."
	.....	.....	79,600	.....	148,950		
The Bonnot Co., Canton, O. (Wm. H. Landreth, Consult. Engr., Jamestown, N. Y.)	22,000	5,000	96,000	84,000	123,000	$111,000	Chemical precipitation.

SEWERS.—Sioux City, Ia.—T. H. Johnson, Cy. Engr., sends us a statement of the bids received Jan. 23 for constructing sewers. The bids per lineal foot are for sewer complete, including excavation and backfilling, and the payment for the work is to be made on monthly estimates in sewerage bonds. The earth is a light alluvial deposit. The contract was awarded to E. J. Hanlon, as stated last week under Sewers, and is to be completed by July 1. The bids, which are considered quite reasonable, were as follows:

Bids Received Jan. 23 for a Sewer at Sioux City, Ia.

	E. J. Hanlon, Sioux City.	J. B. Keef, Sioux City.	Nels Nyatrom, Sioux City.	L. Wesley, Sioux City.	J. E. Riley, Omaha, Neb.	Johnson & Baker, Sioux City.	J. L. Black, Omaha, Neb.	Smith & Conlon, Sioux City.
Section 1 (average cut, 24 ft.).								
70 × 76 in. wooden outlet, 125 lin. ft. at	$6.25	$4.73	$6.00	$15.75	$7.00	$8.80	$8.00	.....
96 × 120-in. open masonry sewer, 200 lin. ft. at	18.00	19.44	23.37	24 98	34.50	30.67	38.20	.....
54-in. circular brick " 270 " "	7.30	9.99	7.56	8.80	7.00	8.00	8.00	.....
72-in. " " " 1,000 " "	10.50	10.33	12.27	12.40	12.50	15.67	14.40	.....
Manholes, 3, each	50.00	63.50	46.75	50.00	100.00	85.34	120.00	.....
Catchbasins "	35.00	78.90	35.85	50.00	47.50	47.34	66.00	.....
Section 2 (average cut, 18 ft.).								
72-in. circular brick sewer, 1,630 lin. ft. at	10.00	9.04	10 04	12.50	12.50	12.67	14.40	11.00
12-in. pipe " " "	.60	1.85	.51	.82	1.00	1.34	1.70	.50
Manholes, 5, each	50.00	47.50	34.37	44.45	100.00	53.34	120.00	50.00
Catchbasins, 16, each	35.00	66.00	35.85	40.00	45.00	47.34	66.00	35.00
Section 3 (average cut, 10 ft.).								
72-in. circular brick sewer, 400 lin. ft. at	7.30	7.72	10 04	11.00	12.50	12.00	14.40	9.89
54-in. " " " 50 " "	4.30	3.92	4.12	6.37	7.00	21.40	8.00	7.42
40-in. " " " 1,160 " "	3.50	2.97	3.30	4.30	5.75	4.54	6.40	4.29
12-in. pipe sewer, 100 lin. ft. at	.50	1 25	.46	.82	1.00	1.34	1.20	.50
15-in. " " 100 " "	.60	1.65	.60	.94	1 25	1.67	1.50	.60
18 in. " " 150 " "	.90	1.98	.95	1.23	1.60	2.67	1.75	.85
15 in. " " 300 " "	1.50	1.58	.60	1.30	1.25	2.47	1.50	.67
Manholes, 7, each	45.00	40.00	34.71	36.90	80.00	53.34	90.00	45.00
Catchbasins, 23, each	35.00	54.50	35.85	49.67	47.50	47.34	66.00	35.00
Total amounts	$43,796	$44,319	$47,256	$55,901	$59,480	$62,025	$68,569	$29,989

Gettysburg, Pa.—A contract for constructing 1,075 ft. of 12-in. pipe sewer, average cut 8.21 ft., has been awarded to J. A. Livers, at 42 cts. per cu. yd., the contractor to furnish the best Portland cement.

ELECTRIC LIGHTING.—Columbus, Ga.—The contract for street lighting for 1894 has been awarded to the Brush Electric Light & Power Co., at $90 for each 2,000-c. p. arc light, moonlight schedule.

GRANITE BLOCKS, ETC.—Cambridge, Mass.—E. H. Reed, Supt. of Sts., informs us that contracts have been awarded as follows: Chas. Wilson, Quincy, 300,000 No. 1 granite paving blocks, 3½ to 4 × 7 to 8 × 7½ to 8 ins., at $37 per M., delivered in this city; Chas. McMahon, Cambridge, 15,000 lin. ft. of granite edgestones and 1,000 lin. ft. of granite circles, each stone to be at least 6 ft. in length, 18 ins. deep, top 7 ins. true to line, pene-hammered and turned on back 3 ins. for brick, at 45½ cts. per lin. ft. for straight and 69 cts. for circle stone, delivered on street; Julius Osterhondt, Kingston, N. Y., 2,500 lin. ft. North River, Belgian bridge, flagging stone, each stone to be at least 6 ins. thick, 2 ft. wide and 4 to 8 ft. long, at 31½ cts. per sq. ft. delivered in this city.

GRANITE BLOCK PAVING.—Trenton, N. J.—The following bids were received for paving Montgomery St., from the Assanpink Creek to Academy St., with granite blocks: E. W. Hooper, $2.73 per sq. yd.; J. A. Meara, $2.94; Thomas Craig, $2.75; R. A. Montgomery, $2.69; New Jersey Paving & Const. Co., $2.75; John F. Shanley, $2.75; Geo. Acock & Son, $2.73; Michael Hurley, $2.70; John D'Arcy, $2.49.

BRIDGE SUBSTRUCTURE.—Chicago, Ill.—The following bids were received for the substructure of the Van Buren St. bridge: 1, Shailer & Schinglau, $76,342; 2, J. L. Paterson, $93,358; 3, Wm. Sooy Smith & Co., $90,747; 4, Chicago Dredging & Dock Co., $87,098; 5, Fitz Simons & O'Connell Co., $74,121. The prices were as follows:

Quantities.	1.	2.	3.	4.	5.
Bedford stone, 486 cu. yds.	$17.00	$23.00	$19.50	$19.50	$20.00
Rubble, 369 cu. yds	5.50	5.50	8.50	6.75	6.00
Port. cem. concrete, 3,116 cu. yds	7.00	8.25	9.50	8.40	8.00
Found. piles, 23,633 ft.	.46	.40	.58	.42	.30
Proteo. piles, 16,270 ft.	.33	.41	.50	.25½	.30
Oak found'n, 6,265 cu. ft.	.38	.45	.50	.43	.40
Pine " 30,328 " "	.37	.38	.45	.33	.30
Oak protect'n, 5,168 " "	.34	.50	.50	.39	.50
Wr'ght iron, 52,850 lbs.	.02¼	.03½	.3½	.05	.04
Cast iron, 13,356 lbs.	.02½	.03½	.03	.04	.03
Steel, 60,000 lbs.	.02½	.04	.03½	.05	.06

SEWER PIPE.—Manchester, N. H.—A. E. Herrick, Clk. St. Comm., informs us that the following bids were received Jan. 27 for sewer pipe for the coming season: Portland Stone Ware Co., Boston, 78% off list price on car-load lots on sizes up to and including 18-in., and 75% off on 20 and 24-in.; Pike & Heald, Manchester, 76½%; T. A. Leane Co., Manchester, 77½%; Waldo Bros., Boston, 77%; Geo. D. Goodrich, Boston, 77½% and 2% additional for cash in 10 days; contract award to Mr. Goodrich, representing the Akron Sewer Pipe Co., Akron, O.

PIPE.—Boston, Mass.—W. E. Swan, Secy. Water Bd., informs us that the contract for 2,405 tons of 4 to 12-in. cast iron pipe, with 100 tons of special castings, and 2,070 tons of 16 to 30-in. pipe with 70 tons of specials has been awarded to R. D. Wood & Co., at $104,280. The McNeal Pipe & Foundry Co. bid $104,947 and the Warren Foundry & Machine Co. $108,230 for the whole amount, and the Radford Pipe & Foundry Co. $62,179 for the first contract.

Evansville, Ind.—A. H. Foster, Clk. Bd., writes us that a contract for 14,025 ft. of 30 to 16-in. cast iron pipe was awarded in December to the Chattanooga Foundry & Pipe Co., at $16.40 per ton of 2,000 lbs., delivered f. o. b. cars in this city, and 2½ cts. per lb. for specials. The contract for a supply of 20 to 6-in. pipe for which bids were received Jan. 29 was awarded to the Anniston Pipe & Foundry Co., at $16.40 per ton of 2,000 lbs., delivered f. o. b. in this city, and 2 cts. per lb. for special castings, the other bids being Ohio Pipe Co., $18 to $19.10, no specials; Howard-Harrison Iron Co., $18.50 and 2¾ cts.; Dennis Long & Co., $17.37 and 2 cts.; Chattanooga Foundry & Pipe Wks., $18.25 and 2½ cts.; South Pittsburg Pipe Co., $17.20 and 2½ cts.; Radford Pipe & Foundry Co., $18.60 and 2 cts.; Addyston Pipe & Steel Co., $17.84 and 2 cts.; Thos. Kelley, Chicago, $17, no specials.

Quincy, Mass.—The water commissioners are reported to have contracted for 1,000 tons of pipe at $22.80 per ton, being $4.70 less than was paid in 1893.

CEMENT SIDEWALKS.—Washington, D. C.—The district commissioners have received the following bids for removing and relaying cement sidewalks under the permit system: Cranford Paving Co., $1.68 per sq. yd.; Geo. Drew & Son, $1.50; H. J. McLaughlin, $1.81; Jacob F. St. John, $1.60.

STREET LIGHTING.—East Orange, N. J.—The committee has recommended that a contract for 165 electric arc lights of 1,250-c. p. capacity be awarded to the People's Light & Power Co., at 24 cts. per light per night. The present cost of lighting the town by gas is about $22,000, and the bid of the Citizens' Gas Light Co. for a new contract for five years was at $19 per year for each light to burn 3,600 hours, $20 for each new lamp and $1.40 per 1,000 cu. ft. for gas for public buildings.

LEVEE WORK.—New Orleans, La.—The contract for constructing the Hurricane Bluff to Willow Chute levee, 102,383 cu. yds., in Bossier parish, has been awarded to W. J. Beatley & Co., at 8.8 cts. per cu. yd. It is stated that the lowest price ever before secured in the state was at 9.5 cts. per cu. yd.——Other contracts for levee construction have been awarded as follows: Manning & Gibson, Natchez, Miss., at 7.74 and 7.75 cts.; Farrell & Watkins, Beulah, Miss., at 9.2 cts.; L. B. Lewis & Co., Memphis, Tenn., at 9.48 cts.; The Whitehall Co., Arkansas City, Ark., at 9 to 19.75 cts.; Timothy Sullivan, Memphis, Tenn., at 9½ cts.; M. McTighe & Co., Memphis, Tenn., at 8.74 cts.; James Kennedy, Gunnison, Miss., at 10.5 cts.; O. B. Crittenden, Greenville, Miss., at 10.75 cts.; P. F. Lamb, Memphis, Tenn., at 9.75 cts.; L. C. Dulaney, Duncansburg, Miss., at 11.75 and 14 cts.; Robert Nicholson, Villa Vista, La., at 16.21 cts.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

HARBOR IMPROVEMENTS.—Chicago, Ill.—The estimates for this year include $177,125 for harbor improvements and $80,000 for canal pumping works.

ARMORY.—Trenton, N. J.—Bids are asked until Feb. 12 for furnishing material and erection of an armory in Paterson. Arch., C. A. Gifford, Newark; Adj.-Gen., Wm. S. Stryker.

DRAINAGE WORK.—London, Ont.—The "Free Press" states that $50,000 of drainage work will be done next summer in the townships of Brooke, Dawn and Enniskillen.

REMOVING LEDGE.—Boston, Mass.—Bids will be received at the U. S. Engineer Office until Feb. 23 for the removal of ledge from Gloucester Harbor. Lieut.-Col. S. M. Mansfield, U. S. A.

STREET SPRINKLING.—St. Louis, Mo.—The board of public improvements has rejected the bids for sprinkling the streets in 18 districts. Some of the bids averaged nearly $600 per mile, while the standard adopted by the board is $400 per mile.

ELECTRIC WIRING.—Harrisburg, Pa.—Bids are asked until Feb. 13 for running electric wires, conduits, etc., in the state library and executive building and in the house of representatives and addition to the senate. Arch., John T. Windrim, Philadelphia; John E. Stopt, Secy. of Comrs.

GRANITE ABUTMENT AND PIERS.—Providence, R. I.—J. S. Tank has been awarded the contract for granite abutments and five piers east of the center line of Francis St. in rear of new station. The work will require 4,000 or 5,000 cu. yds. of masonry, and ground will be broken March 1.

PARK IMPROVEMENTS.—New York, N. Y.—The board of estimate has approved the plans for the following work, which will be done at once: Widening of Bridle Path Road in Central Park, estimated cost $28,000; improving Central Park, $55,000; widening Cathedral Parkway to Riverside Ave., $30,000; work in Morningside Park, $57,000; improving Riverside Park, $150,000.

GARBAGE CREMATORY.—Dallas, Tex.—G. W. Crutcher, Cy. Secy., writes us that the following bids have been received for building a crematory of 75 cu. yds. capacity and guaranteed to thoroughly cremate night soil and all sorts of garbage; L. S. Atkinson, Meadville, Miss., no price given; S. G. Smith, 120 Water St., New York, $12,500; Rider Garbage Co., Pittsburg, Pa, $10,000; Dixon Sanitary Crematory Co., Findlay, O., $4,600 and $6,500; St. Louis Patent Garbage Co., St. Louis, $6,500; Brown & Dabney, Dallas, $6,000; L. D. Busbee, Dallas, $5,000; G. S. Ellinger, Palmer House, Chicago, $12,000.

INDUSTRIAL NOTES.

CARS.—The Pennsylvania R. R. is about to let a contract for the construction of a large number of coal cars of 60,000 lbs. capacity.

THE BUCYRUS STEAM SHOVEL & DREDGE CO., of South Milwaukee, Wis., has built a floating dredge of 3,000 cu. yds. daily capacity for deepening the harbor at Tampa, Fla.

THE ROCHESTER BRIDGE & IRON CO., Rochester, N. Y., has completed the erection of a pin-connected bridge, 187-ft. span and 87 ft. high, on the Adirondack Division of the Delaware & Hudson Canal R. R. Mr. M. Riney, of Chicago, was Superintendent of Erection. It has also the contract for other bridges for this road.

TESTING LABORATORY.—The analytical and assay laboratory of Dr. Gideon E. Moore, 220 Pearl St., New York city, has recently had its factories enlarged by the addition of a department of physical tests under the direction of Mr. Chas. F. McKenna. The laboratory is equipped with Riehle testing machines for tensile, compression and transverse tests of metals, stone, timber, etc., and a specialty is made of cement testing.

THE A. S. ALOE CO., of St. Louis, Mo., is manufacturing a very light transit for mining and surveying, which is also intended for work where extreme accuracy is required. The transit weighs 6 lbs., or 11 lbs. with a light extension tripod and 14 lbs. with a plain tripod. The needle is 2¾ ins. long; the limb, 4¾ in. in diameter, is graduated to single degrees and reads to two minutes, and the telescope has a power of from 18 to 20 diameters. The instrument is provided with level on telescope, vertical arc reading to 2 minutes, and clamp and tangent on axis. The price is $90, complete in box, or $95 with the extension instead of plain tripod.

NEW COMPANIES.—Smokeless Furnace & Gas Mfg. Co., Chicago, Ill.; $1,000,000; W. A. Saunders, G. L. Sharpneck and G. P. Smith.——New York & Long Island Construction Co., Jersey City, N. J.; $100,000. commencing with $5,000, to build railways, tunnels, etc.; L. F. Cozans, New York, N. Y.; J. C. Bradshaw, Orange, N. J.; G. A. Hammet, Jersey City, N. J.——Ajax Steel Coupler Co., Chicago, Ill.; $50,000; L. A. Seymour, George S. Cole and A. B. Williams.——Chicago Cement Sidewalk Co., Chicago, Ill.; $10,000; J. C. Ficklin, M. B. Olmsted and F. M. Lowes.——Van Dyke Construction Co., Chicago, Ill.; $150,000; N. C. Moore, W. B. McIlvaine and Max Baird.——St. Louis Patent Garbage Co., St. Louis, Mo.; $50,000; A. M. Noel, W. H. Garrettson and M. H. Young.

METAL MARKET PRICES.

RAILS.—New York: $24 to $25 at eastern mills and at tidewater; old rails, $12 to $12.50 for iron and $9 to $9.50 for steel. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $11 for iron and $10 for steel.

TRACK MATERIAL.—New York: angle bars, 1.3 to 1.4 cts.; spikes, 1.7 to 1.9 cts.; track bolts, 2.1 to 2.4 cts. with square and 2.3 to 2.5 cts. with hexagon nuts. Chicago: angle bars, 1.4 cts.; spikes, 1.9 to 1.95 cts.; track bolts, 2.5 to 2.55 cts. with hexagon nuts.

FOUNDRY PIG IRON.—New York: $13 to $13.75. Pittsburg: $10.75 to $12. Chicago: $11.75 to $13.

LEAD.—New York: 3.32 to 3.4 cts. Chicago: 3.1 cts.

NAILS.—Pittsburg: $1.05 to $1.10 for wire and 95 cts. for cut at mill.

STRUCTURAL MATERIAL.—New York: beams, 1.55 to 2.25 cts.; channels, 1.6 to 2 cts.; angles, 1.5 to 1.7 cts.; tees, 1.7 to 2 cts.; universal mill plates, 1.5 to 1.65 cts.; steel plates, 1.4 to 1.55 cts. for tank, 1.6 to 1.65 cts. for shell, 1.75 to 2 cts. for flange, 2 to 2.5 cts. for firebox. Pittsburg: beams, 1.25 to 1.3 cts.; channels, 1.25 to 1.3 cts.; angles, 1.25 to 1.3 cts.; tees, 1.5 to 1.6 cts.; universal mill plates, 1.25 to 1.3 cts.; steel plates, 1.25 to 1.3 cts. for tank, 1.4 to 1.5 cts. for shell, 1.5 to 1.6 cts. for flange, 1.75 cts. for ordinary firebox and 2 cts. for railway firebox. Chicago: beams, 1.55 to 1.6 cts.; channels, 1.55 to 1.6 cts.; angles, 1.5 to 1.6 cts.; tees, 1.85 to 2 cts.; universal plates, 1.5 to 1.6 cts.; steel plates, 1.5 to 1.6 cts. for tank, 1.7 to 1.8 cts. for shell, 1.9 to 2 cts. for flange, 2.75 to 5 cts. for firebox.